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" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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④ NATURE

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SATURDAY, JULY 7, 1923.

CONTENTS.

Modern Physics and the Atom.

IN another part of this issue we publish as a special supplement a translation of Prof. N. Bohr's lecture on atomic structure, which was delivered at Stockholm last December on the occasion of receiving the Nobel prize for physics. It seems a fitting occasion to survey the general lines of the recent development of physical theories as to the nature of the atom. The views put forward in Prof. Bohr's address may fairly be regarded as the furthest stage yet reached.

The leading feature of the physics of the twentieth century has been the development of our present concrete picture of the individual atom. In this respect modern physics stands rightly in sharp contrast with previous work—properties of matter in bulk, thermodynamic, electrodynamic, and optical theory. These theories formed the main part of the studies and contributions of physicists before 1900, and advanced with particular rapidity in the latter half of the last century. In all this work, though the atomic nature of matter had already come to general recognition in virtue perhaps of chemical rather than physical evidence, atoms, if recognised at all, play only a secondary part. The reason is that though theories of matter (*e.g.* gases) may be built up on an atomic basis, applications of these theories are always *statistical*; in making them an averaging process is used, and the particular features of an atomic model largely disappear. For example, almost any atomic model will reproduce the main properties of a gas. It is only in the finer points such as the exact variation of viscosity with temperature that the particular form of atomic model becomes relevant, and even here the variation deduced is very insensitive to the model chosen. Crude and vague ideas of the atom—little more than the mere recognition of its existence—were all that were necessary to physics in this phase.

The same is true in a somewhat less striking way of the electronic conception of electricity. This idea became current in a vague form and was shown to be a suitable foundation for the known phenomena of electricity; it was not till some years later that the fundamental experiments on the conduction of electricity through gases first led to a practical demonstration of the existence and main properties of the electron. Just as with atoms, a break-away from statistical deductions was necessary before the electron could be assigned a definite form. The demonstration of its existence and properties, though it belongs historically (1897) to the nineteenth century, is in fact the starting point of what we have called twentieth-century physics.

This concentration on the statistical side was of course inevitable, for the phenomena to which current theories could be applied were mainly concerned, as we have said, with the properties of matter or electricity in bulk. There were, of course, striking and significant exceptions which were already well known for many years before 1900—for example, optical spectra. These had long been recognised as essentially characteristic of particular atoms or molecules, obscured little if at all by any process of averaging. But optical spectra are too complicated and their conditions of excitation too obscure to have formed then a possible basis on which to build theories of atomic structure with any real chance of success. It was necessary to wait first for direct experimental evidence of the more fundamental properties of individual atoms which are unaffected by the widest possible range of external circumstances. It is clear that it is such properties that any atomic model must first set out to reproduce.

The discovery of the nature and properties of X-rays might have provided a new and more hopeful starting point. Here we have evidence of fundamental properties which remain constant and characteristic in all known circumstances. But even this evidence—even, for example, an empirical formulation of Moseley's law—would scarcely have been simple and direct enough for a starting point, and in fact was not available until after the first essential ideas had been otherwise won. The evidence necessary for the start had clearly to refer directly to individual atoms and be such as to lay down with absolute convincingness the main features of atomic structure. It was provided first by the study of radioactivity, and it is difficult to see, as we have tried to show, how any other evidence could have been sufficiently powerful for the purpose. The radioactive evidence soon made it clear that here physicists were concerned with processes connected with the most intimate structure of the individual atom, which outside conditions (physical or chemical) were powerless to affect; and concerned, too, with energy transformations in a single atom so large that the resulting effects could actually be detected. This made it clear that the atom must have an innermost structure, a place apart, the seat of gigantic forces. Ideas of the atom thus began to tend generally in the right direction, and crystallised into the nuclear atom when the nature of the α-particle had been established and the phenomena of its scattering worked out.

It was at this point (1911) that Prof. Bohr's contributions began, and it is convenient to specify the situation in somewhat more detail. It was known that the atom must almost certainly consist of a heavy nucleus, of extremely small size, with a positive electric charge; this nucleus must probably behave, so far as the rest of the world or even the rest of the atom was concerned, as a massive point charge. The nuclear charge must be neutralised in the natural atom by a system of satellite electrons in number equal to the number of units in the nuclear charge. Their arrangement was, however, quite unknown, except that they must with the nucleus compose a structure on the scale of the atom of gas theory—a scale which is exceedingly large and open compared to the dimensions of the nucleus and the electrons themselves. The exact number of satellite electrons or units of nuclear charge was also uncertain, but, by the results of X-ray and α-particle scattering, must be about half the atomic weight. It was almost certain that it was two for helium and one for hydrogen. If these views were to be accepted the hydrogen atom must be very simple—a single heavy nucleus with a unit positive charge, and somewhere near it a single electron; it must also yield the known series spectrum of hydrogen. This was the problem presented to Prof. Bohr. He maintained from the first, and justly as is now admitted by all, that there was no possibility of a solution within the domain of classical electrodynamics, and that the ideas of the quantum theory must be invoked. How these ideas lead inevitably to the accepted hydrogen atom of to-day is set forth at length in the first of his three essays, "The Theory of Spectra and Atomic Constitution," referred to in NATURE of April 21, p. 523, and, more shortly, in the present supplement.

The next essential step was the final assignment of *atomic number*, which connected up once and for all the ordinal number of any atom in the periodic table of the elements, its nuclear charge, the number of its satellite electrons, and its characteristic X-ray spectrum. This assignment, which was, of course, the result of a systematic survey of X-ray spectra, was to some extent directly inspired by the successful theory of the hydrogen atom, and without that theory the full

significance of atomic number would have been missed. At this stage (1915) a general grasp had been obtained of the sequence of the elements and of the essential difference between one atom and the next, in full agreement with evidence of an entirely different type—the displacement laws of α- and β-particle radioactive changes.

In the further elucidation of the organisation of the satellite electrons and the interpretation of the periodic table of the elements, Prof. Bohr has played the leading part. The results obtained are described by Prof. Bohr at length in our supplement. It is sufficient to say here that, thanks to this work, we are now confident that the satellite electrons are arranged in groups. We know the number of electrons in each group. They move about the nucleus in orbits, some of the characteristics of which we already know, and these characteristics are the same for all the electrons of a group. We know, further, the order in which the various groups appear in the system of the elements, and even to a limited extent why the actual order must be observed. This information is summarised in the supplement (Fig. 9). The details of the picture—important details—have yet to be filled in, but we can no longer doubt that we are advancing on the right lines.

In conclusion, one may glance for a moment at the profound reaction of these views of atomic structure on physical research. In return for their spectroscopic basis in the Balmer series, they have revolutionised spectroscopy, which is now—X-ray and optical alike—one of the main avenues of advance in physics. They have created a whole new and fruitful branch of study, the excitation of atoms by electronic impacts. They provide a concrete picture of the atom which can form, and is forming every day, a trustworthy basis for the study of all branches of atomic phenomena. Finally, one must expect that the facts of chemistry will not much longer stand apart. Though much formal progress has already been made in the theory of valency, the detailed electronic theory of the structure of molecules has yet to be begun; it will inevitably present grave difficulties. But these views of atomic structure have, for example, already presented us (unasked) with a carbon atom with tetrahedral symmetry; they lead us confidently to expect that the first advances in the detailed theory will not be long delayed.

The Conquest of Malaria.

Memoirs: With a Full Account of the Great Malaria Problem and its Solution. By Ronald Ross. Pp. xi + 547 + 11 plates. (London: John Murray, 1923.) 24*s*. net.

IN Sir Ronald Ross's "Memoirs" information is to be found which will interest the conventional "wide circle of readers," in that the subjects treated must appeal to the Imperialist, the political economist, the sanitarian of the tropics, and the cosmopolitan science research worker; nor will those who respond to the "call of the East" fail to find interest in details of scenery and travels in India and Burma. Among the items illustrating the importance of research in aiding the well-being of communities and nations are discussed the conditions under which the discovery of the agency of malaria conveyance was made, as a result of the laborious experimental efforts of the author. In the section dealing with this subject will be found a tale devoid of technicalities of relentless search for a scientific truth, with its recurring disappointments, baffled schemes, renewed hopes, and ultimate victory, which, in entrancing interest, may compete with Sherlock Holmes's efforts at his best.

For centuries, the problem of malaria afforded a favourite subject in medical writings for opinions and disputations. By 1880 Laveran had found the *plasmodium malariæ* in the blood of human beings; but the vital matter, in respect to prevention, as to how the protozoon gained entrance to man remained a mystery. In 1894 Manson excogitated an hypothesis as to malaria agency, which was published in detail in the *Lancet* (vol. 1., p. 1309). Ross was in England in that year. Between the younger man, eager to remedy the distressing conditions arising from this cause in India, and the older, glad to find an enthusiast in malaria prevention, there arose a mutual professional interest and interchange of views, which continued during Ross's labour in that country. It has since been insisted that Ross was a mere marionette under the control of Manson; indeed, that he was "selected"[1] by the latter for this particular work, and that Manson was the "discoverer of malaria."

Where admiration for Manson can justly be given in this matter is in contemplating his reasons for framing the hypothesis of 1894, namely, that it might prove an incentive to research on malaria which, as he asserted (*Journal of State Medicine*, September 1900), "is far and away the most important of the many problems of tropical empire—that empire upon which so much of our present and of our prospective national prosperity depends." No claim to originality was made by him, and with the one exception (added in 1898 to the original conjecture of 1894) that the flagella

[1] This is a particularly inapt contention, seeing that before Ross "selected" himself for this limitless task (p. 131, "Memoirs"), Manson had issued with his hypothesis of 1894 an invitation to medical men in India generally (*British Medical Journal*, vol. i. p. 1309) to undertake research on the lines suggested, and, after Ross had furnished him with results, repeated this invitation in 1896 (*B.M.J.* March 28). In 1898, when Ross had arrived at an important stage of his discovery (*B.M.J.* p. 1576, 1898), Manson decided "again to call the attention of workers on malaria to this promising field for investigation." Further, Ross, both officially and privately, in India strove to induce others independently to undertake the task. Meanwhile Manson did not utilise material available in England (pp. 131, 147 "Memoirs").

of the plasmodium were "flagellated-spores" (which was an error), no originality is recognizable. By dovetailing various views of acknowledged authorities with the analogy of filariasis, as previously suggested by Laveran, he attempted to meet the then current opinion of transmission of malaria to man through the medium of air or water.

The "Memoirs" show that up to 1896 Ross had laboured to prove the hypothesis of Manson, and that mosquitoes, fleas, bugs, horse-flies, and cockroaches had been duly examined, while direct experiments upon human beings had been made as to conveyance by water, with the result that he informed Manson that "the belief is growing upon me that the disease is communicated by the bite of the mosquito" (pp. 176, 190, 193). To this Manson replied, "It may be the mosquito conveys the parasite by biting, but I do not think so—at all events, I do not think so directly." Ross now informed Manson that he was "dying to go away to some regular hotbed of malaria"—the object obviously being to secure possible factors in intense occurrence. He obtained short leave from military duty, and proceeded to a spot popularly held to be the haunt of a deadly form of malaria—Sigur Ghat in the Nilgiris Hills. This resolve was the turning-point of his investigation. A detail concerning his return to Bangalore, where he was stationed, does not appear in his "Memoirs." A friend perceived a mounted man approaching him gesticulating excitedly. This proved to be Ross, who shouted "I've got it—I've got it!" Naturally, a fortune by a sweepstake or the like was "sensed," but a demand for enlightenment elicited the banal reply, "I've got the fever." He had been able to concentrate attention upon air, water, and the mosquito as factors, with the crowning joy of suffering from fever; he was able to adopt a "mathematical line of reasoning," which pointed to the chances of the malarial germ being conveyed by the mosquito direct to man rather than in a form diluted by air or water. Thereafter, he could say with Newton that he did not deal with hypotheses but with facts. On August 20, 1897, Ross identified the first stage of development of the plasmodium in the mosquito. It would deprive the reader of interesting details were the further history of his efforts traced. Suffice it to say that by July 9, 1898, Ross *had not proved but had disproved Manson's hypothesis of 1894*.

Ross has roundly declared time after time, and in various forms, that it was Manson's "great induction which did it—nothing else," and that he had received advice from Manson. These affirmations have been misconstrued. Lister, after entering judicially into the attempted piracy of Ross's discovery by certain Italian savants, gave his opinion thus: "The discovery of the development of the parasite in the mosquito was due solely and simply to Major Ross, who had shown absolute candour, perfect openness of mind, and a readiness to recognise the work of others." Throughout the "Memoirs" these attributes are unconsciously displayed by the author.[2] The advice as to technique given by Manson was based upon special knowledge of filariasis—it was found inapplicable by Ross to his requirements; it was, nevertheless, courteously acknowledged. The "great induction" referred to the function of the flagella, and, when deprived of Manson's erroneous suggestion as to these being spores, did not differ materially from the views expressed previously by Laveran and Mannaberg. Ross, however, justly held that, by insisting that the flagella had some undiscovered yet important biological function, Manson had provided an *incentive* to research, which he handsomely acknowledged.

Manson had the gratification of finding that he had been the factor in inducing one man, among hundreds of potential workers to whom he had made an appeal broadcast, to undertake research on what he believed to be (*British Medical Journal*, 1898, p. 1576) "the logical outcome of well-ascertained facts, . . . and the most promising guide to fresh facts." That one man was Ross, whose inner consciousness, as early as 1890-93, had been stirred to discover means for averting the misery incident to malaria in the populations of India. In his poetic record, under the title "Indian Fevers," he had written, "O God reveal thro' all this thing obscure, the unseen, small, but million-murdering cause" ("Philosophies," p. 21); and, on the day when he realized that his invocation had been answered, wrote, "This day relenting, God hath placed within my hand a wondrous thing; and, God be praised, I know this little thing a myriad men will save."

Ross had definitely undertaken his research—not in the quest of abstract science—but in the interests of preventive medicine. His next hope therefore was to be allowed to apply methods based on his discovery. The Government of India (in which country one million deaths occur yearly from malaria), however, not only failed to issue so much as the usual stereotyped "thanks of Government," but also refused to promise him facilities. Rather than leave matters thus, he retired from the Indian Medical Service; with a pension one-fourth the value he might have secured

[2] At forty years of age, he had still to learn that the compendium to the tenth Commandment—"nor anything that is his"—was liable to be forgotten by pseudo-men of science, and that, with Governments, the axiom "Politics first" and "deil tak' the hinmost" allows little room for financing the interests of so trivial a fad as disease prevention. Difficulties encountered are factors in evolution—sometimes beneficent; in the case of the author, for many years since he arrived at that age of discretion, in public speeches and in literature, he has proved a powerful advocate of aid to research workers.

by continued service. But this personal sacrifice (added to the considerable private expenditure during his investigation) enabled him to complete his work, by demonstrating the applicability of its benefits in West Africa and Ismalia. The King-Emperor has conferred honours (not, however, upon the recommendation of the Government of India) upon the man who had made, as Manson said, the discovery of the century (p. 317).

Following the adoption of anti-malaria methods based on knowledge gained by Ross, invaliding and sickness in the British garrisons in the tropics have been reduced to an extent which must represent many thousand pounds—irrespective of human suffering—saved; great mercantile firms have extended trade to areas they formerly shunned from dread of the malaria fiend, and these share the benefits of commerce consequent upon the opening of the Panama Canal, the construction of which had proved impossible in the hands of the French—owing to the ghastly mortality of employees—in the absence of Ross's methods; during the great War, according to the Official History (vol. 2, p. 238), "the loss of the strength to the armies from the effects of malaria was great, and *but for the preventive methods adopted it might have been incalculably greater*" (italics not in the original). What has the nation, the Parliament of which voted 30,000*l.* to Jenner in token of gratitude, done for this practical philanthropist?

In "Memoirs" covering many years and many localities, the author has left little room for criticism as to accuracy. At p. 223, the date of his first gleam of success is erroneously stated in the text; fortunately, the next page is faced by a facsimile which correctly shows the date to have been August 20, 1897; at p. 327, in referring to Haffkine's good work, it is evident the date 1916 should read 1896; at p. 198, in reference to the use of "bird's malaria," the context would show that the intention is to refer to 1896 and not 1906. The Madras Presidency can claim freedom from the conception that (p. 200) "though plague had broken out for some years in China, almost no precautions had been taken to exclude it from India." It is inaccurate to describe Mr. E. H. Hankin, the able bacteriologist, as "the discoverer of the mode of purifying wells by permanganate of potassium." He did not initiate the method; to him is the credit of showing that the cholera vibrio is killed by the chemical, and is not starved out of existence by its action on organic matter. The Hindu title of "Maharaja" used in connexion with the independent potentate mentioned at p. 101 will doubtless be corrected in future editions of the work.

W. G. King.

Variable Stars.

Specola Astronomica Vaticana V. Herausgegeben von Johann Georg Hagen, S.J., und Johann Stein, S.J. Die Veränderlichen Sterne. Erster Band: Geschichtlich-Technischer Teil. Von Johann Georg Hagen, S.J. Pp. xx+811. (Freiburg im Breisgau and London: Herder und Co. G.m.b.H., 1921.) 42*s.*

Though the subject of variable stars, apart from still earlier beginnings, has been actively studied for a century, and the realisation of its importance has been reflected in a growing volume of technical literature, it has not hitherto received extended discussion on historical lines in a work exclusively devoted to this branch of astronomy. The first volume of such a work, for which Father Hagen assumed responsibility, has now been completed by the inclusion of a fourth and last part, on the elements of the light-change, the three earlier parts having been issued separately from the year 1913 onwards. The remaining second volume, which will deal with the physical explanations of the phenomena of variable stars, is in the hands of Father Stein, and its appearance will be anticipated with interest.

In these days, when the insistent demand for summaries even to the most condensed papers betrays the fact that honest reading is out of fashion, there is something impressive in an ample and scholarly work like this, with its more than 800 quarto pages. The three earlier parts dealt with the equipment of the observer, the actual observation of variable stars, and the reduction of the observations. References to other methods will be met with incidentally, but it is to the visual method in its historical development that the work is almost exclusively devoted. Naturally there are parts of the subject which are largely independent of the particular method of observation, and the discussion of them will serve a more general application.

To avoid misconception as to the nature of the work and its limitations, it will be well to refer to an explanation given at the outset in the preface. There it is stated clearly that for the principles of photometry, the practical details of astronomical photography, the description of all the various forms of apparatus and those parts of mathematical theory which are involved in the discussion of the observations, the reader must consult in each case the appropriate text-book or even an encyclopædia. To this it should be added that the book contains no figures or illustrations, and that very little space is occupied by tabular matter. Thus it is in no sense a text-book suitable for the needs of the ordinary observer, but an historical work from which the lessons of past experience can be derived from

documentary evidence. It may easily be felt that judicious compression of the abundant material, so far from diminishing, would have positively enhanced the value of the work. Moreover, while a full treatment of those technical matters, which have a general character and yet find a particular application in this special subject, would have been out of place, short explanations based on first principles could sometimes have been interpolated with material advantage to the general reader. But it is as an historical work of reference that the volume now completed must be judged, and as such it will bring the author of the "Atlas Stellarum Variabilium" the renewed gratitude of all those who are interested in this branch of astronomy. H. C. P.

The Study of Fossils.

Animals of the Past: an Account of Some of the Creatures of the Ancient World. By F. A. Lucas. Sixth and revised edition. (Handbook Series, No. 4.) Pp. xii+207. (New York: American Museum of Natural History, 1922.) n.p.

IN 1901, when Dr. Lucas was a curator of the United States National Museum, he published a most useful popular book on the study of fossils, with special reference to the remarkable extinct vertebrate animals found in North America. A decade later, when he became director of the American Museum of Natural History, New York, he reprinted his work as one of the handbooks of that museum, where it has had a large sale. He now has issued a much-revised edition, with numerous new illustrations from fossils actually in the American Museum.

Dr. Lucas's little treatise is neither a museum guide nor a text-book, but consists of a series of gossipy chapters, each on a special subject, admirably designed to rouse an interest in the study of fossils. He explains their nature, describes how they are collected and made available for science, and leaves the reader in a frame of mind to appreciate more systematic and technical works on the subject. At the end of each chapter, indeed, he refers to some of the more important literature, besides mentioning the chief American museums in which illustrative specimens can be seen.

Among the new matter may be specially mentioned a discussion of Mr. Beebe's theory of the origin of flight in birds, a chapter on flying reptiles with some good illustrations from Seeley's "Dragons of the Air," an account of Tyrannosaurus and the giant Eocene bird Diatryma, additional figures of dinosaurs, and a photograph of the restoration of the American mastodon in the State Museum at Albany. There is also a photograph of an engraved bone found in a cave near Pineville, Missouri, in 1921, which seems to show the rude outline of an elephant, either mammoth or mastodon.

Dr. Lucas writes, of course, primarily for American readers, and it is natural that he should place American discoveries in the front rank; but he is wrong in stating that "the largest single bone of a Dinosaur" is the thigh bone of Brachiosaurus at Chicago—it is three inches shorter than the humerus of the African Gigantosaurus at Berlin. The rivalry between the American palæontologists and their colleagues in the Old World is one of friendly emulation, which has led to great discoveries in more than one hemisphere.

A. S. W.

Our Bookshelf.

Methods and Experiments in Mental Tests. By C. A. Richardson. Pp. 94. (London, Calcutta, and Sydney: G. G. Harrap and Co., Ltd., 1922.) 3*s*. 6*d*. net.

IT is difficult to perceive for what type of audience Mr. Richardson's book is intended. If it is meant for readers who have no knowledge of any of the literature on the subject, then it is surely out of place to introduce the subject by a rather perfunctory discussion of the criticisms made against the use of tests. If, on the other hand, it is meant for readers already conversant with some of the work done, then much of the discussion is useless. The same remark applies to the statistical account.

The details of the experimental testing of groups of children are very interesting, but would have been more suitable for an article in a psychological journal than for a book.

The Organisation and Administration of Physical Education. By Prof. Jesse Feiring Williams. Pp. xiii+325. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1922.) 9*s*. net.

DR. WILLIAMS urges the necessity for physical education to be placed on a scientific foundation, and gives such a basis with a wealth of detail which is rarely associated with the subject. Indeed, it is carried to an extent which, in Great Britain, is unnecessary. The chapter on health and efficiency is the least scientific; little reliance can be placed on tests involving such factors as height and weight charts, and the ratio of the girth of the arm to that of the chest. The general purpose of the book is good, and it should provide a stimulus to interest in physical education.

Character and the Unconscious: A Critical Exposition of the Psychology of Freud and of Jung. By J. H. van der Hoop. Authorised Translation by Elizabeth Trevelyan. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. viii+223. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1923.) 10*s*. 6*d*. net.

THIS is a general and rather superficial account of the theories of Freud and Jung. The author tells us it is the result of nine years' intensive study of the practice and theory of psycho-analysis, which seems to mean that he has been a practitioner during that period. The translation is well done.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Positive Ray Analysis of Copper.

THE chief difficulty in analysing an element with a high melting-point by means of positive rays lies in the construction of a suitable furnace for evaporating the metal. I have recently succeeded in obtaining rays of copper by using a molybdenum furnace, heated with a coil of molybdenum wire embedded in alundum cement. Three isotopes were observed separated by two units in atomic weight. The relative intensities were about 1·4 : 1 : 1, the lightest being the strongest. Rays of rubidium were also obtained, probably from the cement, and showed two isotopes, as found by Aston with his method of analysis. The relative intensities gave a mean atomic weight of 85·51, in good agreement with the chemical atomic weight 85·45. To obtain agreement with the chemical atomic weight of copper 63·57, it is necessary to suppose the isotopes to be 62, 64, and 66, since this gives a mean atomic weight of 63·76, which is as close as would be expected. A direct comparison with rubidium is desirable, but further experiments will be necessary before the comparison can be regarded as conclusive, since the rubidium rays probably start at the surface of the cement and may fall through a different potential from the copper rays. A few comparisons suggested the even atomic weights, so that we may provisionally take the isotopes of copper as of atomic weights 62, 64, and 66. This seems to mark the first exception to the rule observed by Dr. Aston to hold for chlorine, potassium, bromine, rubidium, and antimony, that elements with odd atomic numbers have isotopes with odd atomic weights, and may be connected with the fact that copper occupies a place in the series of elements where the atomic weights begin to increase rapidly with atomic number.

A. J. DEMPSTER.

Ryerson Laboratory, Chicago,
June 9.

Expansion of the Wings of Lepidoptera after Emergence from the Chrysalis.

No one who has watched a butterfly or moth emerging from the chrysalis can fail to have been impressed by the rapid expansion of the wings. This expansion is not real growth, but merely the opening out of the contents of a carefully packed parcel, and the general character of the changes which occur in the process is well known.

FIG. 1.—Pupal and extended wings of V. Jo (distance between lines = 1 inch). The pupal wings were removed from the chrysalis just before emergence.

The true growth of the wings takes place and is completed in membranous sacs just within the walls of the chrysalis, and the form of the wings can be distinguished from the outside. The position of the wings during their development is such that the upper surface of the fore wing is next to the wall of the chrysalis, and within a day or two from the time of hatching the colours and markings can in many cases be recognised.

Each wing consists of two separate membranes, united with the nervures, on which the scales are mounted, the stems of the scales entering sockets in the membranes placed in fairly symmetrical rows, though the irregular shape of the spaces between the nervures prevents the symmetry being exact.

The point to which the present note is intended to direct attention is the numerical relation between the

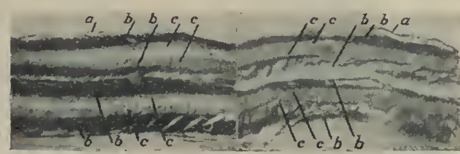

FIG. 2.—Section of pupal wings parallel to the nervures. × 60.

FIG. 3.—Section of pupal wings at right angles to the nervures. × 60.

Sections in Figs. 2 and 3 were cut from the chrysalis, and show both the fore and hind wings.

size of the pupal and expanded wings, and the reason for the constancy of this relation. In all the lepidopterous wings which I have examined the pupal wing has very nearly one-third of the dimensions of the wing of the perfect insect (Fig. 1).

If the fully developed wing is removed from the chrysalis and sectioned, the reason for the one-to-three ratio is immediately evident so far as regards extension parallel to the nervures, but the "accordion" folding whereby the scale-bearing membranes expand in a direction at right angles to the nervures is rather more complex.

FIG. 4.—Section of extended wings parallel to the nervures. × 60.

FIG. 5.—Section of extended wings at right angles to the nervures. × 60.

These sections are from the posterior part of the fore wing not far from the margin.

The section parallel to the nervures is shown in Fig. 2 and diagrammatically in Fig. 6. Here the wing membrane is seen folded so that the distance from fold to fold is the same as the depth of the fold, and therefore the extended is three times that of the folded dimension. To realise the character of folding in the other principal direction, imagine a series of camera bellows fully extended A_1A_2, etc., to be placed side by side, Fig. 9, so that the sides C_1C_2, C_2C_3, etc., will remain in contact when the bellows are contracted. Then remove the lower sides B_1B_2, etc., and join the free edges of C_1C_2, C_2C_3, etc. It is clear that the surface thus formed is developable, and that if, to start with, the bellows are compressed to one-third of their extended length the developed surface will in all directions have three times the dimension which it has when folded.

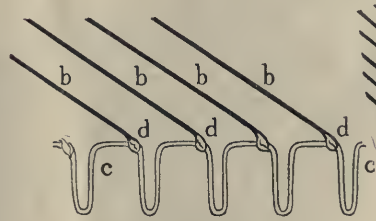

FIG. 6.—Diagrammatic section of pupal wing parallel to the nervures.

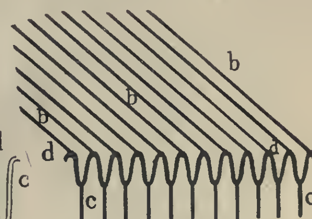

FIG. 7.—Diagrammatic section of pupal wing at right angles to the nervures.

The letters refer to those in Figs. 2 to 7.—(*a*) Wall of chrysalis; (*b*) scales; (*c*) wing membrane; (*d*) sockets in membrane.

The section of the membrane cut in this direction presents a much more complex appearance (see Figs. 3 and 7) than that parallel to nervures.

The compression to one-third of the extended dimension in the transverse direction appears to be

due to the space occupied by the "accordion" folds, and a diagrammatic sketch of the folded membrane seen in plan with the scales removed is given in Fig. 8.

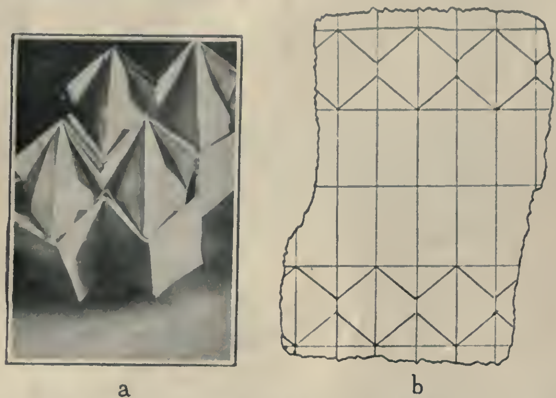

FIG. 8.—(*a*) Bird's-eye view of cardboard model showing the upper surface and side of the folds partly extended. (*b*) Developed surface of card showing the lines of folding.

The positions in which the sockets for holding the stems of the scales occur are shown at *d* in Figs. 6, 7, 8. In the pupal wing the scales are closely packed like the pile of a carpet, but after expansion lie close, and nearly parallel to the extended wing membrane, see Figs. 4 and 5.

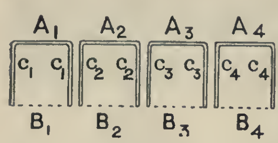

FIG. 9.—To illustrate the formation of an "accordion" folded sheet.

The mechanical means whereby the extension is effected is, I believe, of much the same nature as pumping up a pneumatic tyre, fluid being injected into the nervures by the muscular action of the body; but this is a point requiring further observation. So far as I know, it is only in the Lepidoptera that the 3 to 1 expansion occurs, but it seems probable that the same form of stiffening by injection acts in all wings supplied with nervures.

A. MALLOCK.

April 30.

The Formation of New Egg Cells during Sexual Maturity.

IT is generally believed among mammalian embryologists that during the life of the individual there is no increase in the number of primary oocytes beyond those originally laid down when the ovary was formed. This idea has grown from two sources of evidence—one, from the Weismannian doctrine of the germ-plasm; the other, from the fact that it is difficult to find any evidence for post-natal formation of new oocytes by metamorphosis of any non-germinal ovarian cell.

The problem of the origin of sex-cells in general introduces two questions about which much discussion has taken place. The first of these questions is how the first germ cells arise; the second, whether somatic cells can change into egg cells. Many, accepting fully the work of Beard, that doyen of embryologists, and of Woods, who showed that the germ cells of certain Vertebrata originate as large pale cells of the yolk-sac endoderm, at the same time consider that the view that no somatic cell can metamorphose into a germ-cell needs more evidence than the description of germ-cell migration. Apart from this important question, some zoologists believe that no accession of new egg cells takes place during the post-natal life of any craniate vertebrate, but the evidence produced by Bouin, Braun, Ludwig, and the writer would seem to be conclusive for fish, amphibians, and reptiles.

The attached photo-micrograph (Fig. 1) of the adult frog ovary shows a large ovarian tag containing germ cells in all stages, and it is indisputable that in vertebrates below the mammals seasonal accessions of new germ cells take place.

So far as the mammals are concerned no observer within recent years has attacked the problem, but Edgar Allen in the *American Journal of Anatomy*, vol. 31, No. 5, has now published a paper in which he claims that a cyclical proliferation of the germinal epithelium gives rise to a new addition of young oocytes in the cortex of the adult ovary of Mus at each normal oestrus period. This new paper appears to me to contain the results of much careful work, and it upholds the views expressed by the Waldeyer school of embryologists.

So far as the mammal is concerned, it may be taken that since the necessity for large numbers of fresh proliferated germ cells is usually absent, these do not

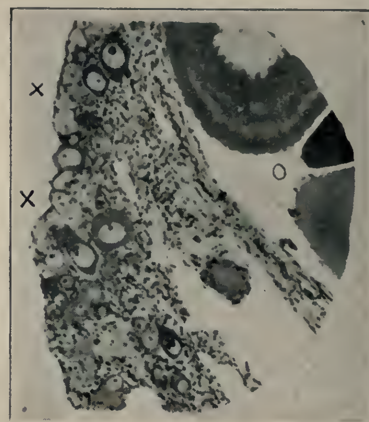

FIG. 1.—Photomicrograph of adult ovary of Rana. At X, X, are leptotene and pachytene stages of oogenesis, as well as large numbers of later oocytes. At O_1 is a part of the rest of the ovary with large eggs.

generally occur in those forms which produce few young. The writer, through the kindness of Prof. J. P. Hill, has lately examined several ovaries of Ornithorhynchus without finding any signs of oogonia in the adult: the material was not extensive enough, in the light of Edgar Allen's work, to pronounce a definite verdict, but I believe Ornithorhynchus does not produce litters of young like the rodent. It is worthy of note that Allen's descriptions of photomicrographs correspond to the descriptions and figures already given by the present writer for Rana and Bufo. Allen's Plate 5 is very striking evidence; he has, moreover, demonstrated completely the cyclical mitotic divisions and activity in the germinal epithelium of Mus.

The opponents of the germinal epithelial theory will naturally say that Allen's cells are derivatives of the migrated primitive germ cells; but unless some obvious difference can be shown to exist between the germinal epithelial cells and the forerunners of the cells described by Allen, we are justified in assuming that the new egg cells are derived from metamorphosed epithelial cells, and certainly from cells which have lost their individuality in the formation of the so-called somatic part of the ovary.

The statement, often made, that only primordial germ cells can produce gametes, and that the metamorphosis of epithelial cells into germ cells does not take place, needs also the assumption that the potential-

ities of the somatic cells are curtailed by some special cytological mechanism, which, be it marked, has not hitherto been described by any one in the Vertebrata.

The nearest approach to such a mechanism is the chromatin-diminution process in Miastor, an insect in which all but the germ cell nuclei are deprived of part of their chromatin. Nowadays, however, few zoologists wish to repeat the mistake of Weismann in deducing too much from the peculiar cytology of the holometabolous Hexapoda, which develop under special conditions. J. BRONTË GATENBY.

Trinity College, Dublin,
June 9.

Origin of certain Filamentous Forms from Eocene Beds.

A PAPER by Prof. T. D. A. Cockerell has just appeared entitled "The Supposed Plumage of the Eocene Bird Diatryma" (*Amer. Mus. Novitates*, No. 62, 1923), describing certain filamentous bodies from Eocene (Green River) beds of Colorado.

Prof. Cockerell states that the specimens "are not vegetable fibres, nor are they mammalian hairs," but resemble the simple feathers of birds like the cassowary, and he refers them (with a query) to a new species of Diatryma because this is the only known Eocene bird from which they could have come.

Prof. Cockerell has been good enough to give the original of his Fig. 1B to the Geological Department of the British Museum (Natural History), and an examination of this specimen has failed to convince me that it is not of vegetable origin. Similar strands of filaments occur in Upper Eocene rocks of Haering, Tyrol, for example, and are derived from decayed leaves of palms (*Sabal major*, Ung.), into undecayed portions of which they are sometimes seen to pass. These fibres in specimens from Haering are absolutely indistinguishable from those in the original of Prof. Cockerell's Fig. 1B, and, though it is difficult to arrive at any definite conclusion from such fragmentary material, it seems quite possible that the supposed feathers may be only fibres from a decayed monocotyledonous leaf. W. N. EDWARDS.

Geological Dept.,
British Museum (Natural History), S.W.7,
May 26.

Hafnium and Celtium.

IT is with great interest that I have read the communications of Dr. Coster and Prof. Hevesy in NATURE on the new element, hafnium. Under the title "Correlation of Atomic Structure and Spectra" (Journal American Chemical Society, xliv., p. 328, 1922) I discussed the properties of the unknown elements from the point of view of Bury's theory of atomic structure, and stated: "No. 72 possibly is Urbain's celtium. But Bury's arrangement gives the electron structure 2. 8. 18. 32. 8. 4 for this element, which is consequently tetravalent, while Urbain describes celtium as being intermediate in chemical character between Lu and Sc, both trivalent elements. A further investigation of the chemical properties and the X-ray spectrum of celtium is therefore desirable." This article was received by the editors of the Journal, November 22, 1921, and, I believe, is the first published suggestion that the chemical properties of celtium as given by Urbain do not agree with theoretical considerations of atomic structure.

HAROLD S. KING.

The Chemical Laboratory, Dalhousie University,
Halifax, Nova Scotia, May 12.

Distribution of *Limnæa pereger* and *L. truncatula*.

SOME recent observations on a subject lately discussed in the columns of NATURE may be of interest. The freshwater snails, *Limnæa pereger* and *L. truncatula* are widely distributed over this district, where *Distomum hepaticum* is a serious pest: the two molluscan species occur in almost every body of fresh water where the topographical conditions are suitable, excepting only such as are seriously polluted by the effluents from old lead-workings. The hydrogen ion concentration of the fresh waters varies generally from about P_H 6·4 to P_H 6·9.

While studying a neighbouring area, a portion of the Plynlimmon plateau, about 12 to 15 miles from Aberystwyth, I was struck by the almost complete absence of freshwater molluscan species. Two only were found: *L. pereger* and *Ancylus fluviatilis*, the latter in a single locality only, the former in this and one other locality. The hydrogen ion concentrations of the waters in these two localities were P_H 6·4 and P_H 6·5 respectively: both are exceptional figures for the area, where the P_H values as a rule range from 5·8 to 6·2. (Peat bogs abound in the district.)

Laboratory experiments show that *L. pereger* invariably dies within 2 to 3 hours after being placed in water of P_H value 5·6. (Distilled water which had been exposed to the air was used for these experiments; also tap water, which has here about the same P_H value.) A characteristic reaction is given, the first phase of which is the nearly complete extension of the body beyond the shell, with violent twisting movements. Eventually the animal dies in retraction, with much exudation and coagulation of mucus. I intend before long to carry out similar experiments with *L. truncatula*. Several other freshwater species show a similar reaction, the coagulation of the mucus being especially noticeable.

KATHLEEN E. CARPENTER.

Zoological Department,
University College of Wales,
Aberystwyth.

Scientific Names of Greek Derivation.

IN the course of the interesting notice of Stille's "Die Schrumpfung der Erde" in NATURE of June 2, reference is made to "What G. K. Gilbert styled 'epeirogenic' (now written 'epirogenetic')." The latter termination is no doubt more correct, but the spelling of the second syllable involves a more debatable question. Some of us are by no means reconciled to the system of the Latinisation of Greek names, now widely followed, especially on the other side of the Atlantic. It is a distinct misfortune that Greek should reach the nomenclature of science by way of a language poorer in both vowel and consonantal sounds. To write "dinosaur" for "deinosaur" is to obscure the derivation of the word. So long as most of our scientific terms are derived from Greek, it is obviously desirable that they should be written in English in a form as closely similar as possible to the original, so that a student can look them up in a lexicon even if he knows but little more of the language than the letters.

I am glad, however, to see that your reviewer, when he is at liberty to follow his own predilections, prefers to adhere as far as he can to the Greek spelling. Does he not speak of "Okeanos, lord of the great outer seas"? JOHN W. EVANS.

Imperial College of Science and Technology,
S.W.7, June 4.

As the reviewer referred to, I warmly welcome the remarks of Dr. J. W. Evans on the tendency to modify Greek forms, sometimes beyond recognition, when they are introduced into scientific terminology. I went to some trouble in looking up Gilbert's "epeirogeny," which Sir A. Geikie of course spells correctly in his "Textbook of Geology." I have long clung to "deinosaur," and American authors should bear in mind that the use of an i for ei complicates pronunciation when the terms are handed on to other nations.

The chief offender, however, was Charles Lyell, who knew that he was doing wrong when he wrote his footnote on p. 53 of the third volume of the "Principles of Geology" in 1833. He justified his "Miocene" and "Pliocene" by the use of "encenia" and "icosahedron"; but the result has been the absurd American term "Cenozoic," which, if it means anything, should remind us of the emptiness of life.

The frequent use of the prefix "epi" makes one anxious to preserve "epeirogeny." I wish that we could mark the first e with a stroke to keep it long, and this remark applies also to "Tethys." But in the face of "Epirus," and "Pisistratus," and "Phidias" it is difficult to be logical. May we not attempt, however, as Dr. Evans suggests, to keep our newly invented scientific terminology from degenerating like our common speech?

GRENVILLE A. J. COLE.

On the Significance of "Rings" on the Shells of Cardium and other Molluscs.

IN NATURE of February 3, p. 146, I referred to experiments on determining the rate of growth of a fixed population of marked cockles (*Cardium edule*). In this experiment the box which was fixed in the bed of the River Yealm and contained the cockles was visited monthly, and sometimes at intervals of only a fortnight, for the purpose of measuring the increment in growth since the previous visit. This method of work resulted in an interesting observation on the formation of rings on the shells of the growing cockles. It was found that in the young cockles, *i.e.* up to about 16 mms. in length, dark rings were formed monthly or fortnightly in a majority of cases, on the shells at the size they were when last measured, but that no similar formation of rings could be detected in the larger and generally older shells. On the other hand, both small and large cockles showed distinct rings after the winter period.

In young cockles, growing in length at the rate of one millimetre or more a week, a cessation of shell-growth for a few days as a result of being taken out of their habitat and handled is enough to produce a distinct ring, but older cockles which increase *in length* a very small amount in even a month show no external sign of a small period of cessation in growth. Thus rings on the shells of cockles are undoubtedly due to periods of cessation of shell-growth, and the length of the period necessary to produce an effect depends directly upon the size of the cockle.

In this connexion it is interesting to read the history of cockles picked up haphazard. Some shells I picked up on the shifting sands of the bar at Padstow showed numerous rings close together, and there is no doubt that these rings can be interpreted as periods of cessation of shell-growth probably separated by only a few weeks, and due to the cockles being embedded deep in the shifting sand after rough weather. On the other hand, cockles picked up in protected situations show mostly those rings which can be interpreted as winter rings, but often also near the umbo, tiny rings which may mean the occurrence of a disturbance for only a few days while the individual was young. Similar winter rings have been found by experiment in Crepidula and in many cases in Patella, but Patella may not show winter rings in some situations at Plymouth after a mild winter.

In fishes the indications of periods of growth and of cessation of growth are very important, and in view of the observations mentioned above it would be interesting to know whether the otoliths and scales of *young* fishes, which show distinct rings (apparently produced in winter and summer), would reflect the effects of short periods of an analogous disturbance in the same way as the shell of the cockle.

J. H. ORTON.

Marine Biological Laboratory, Plymouth,
June 19.

A Crystallisation Phenomenon.

THE attached photograph (Fig. 1, natural size) is of interest, as it illustrates a phenomenon which does not appear to have been recorded.

For certain experiments it was necessary to purify some samples of salicylic acid, and recrystallisation from hot water was resorted to. The work was carried out in a litre conical flask, and a layer of crystals was formed at the surface of the solution on cooling. Below this layer many crystals were seen to be suspended by threads, and as the photograph shows, one thread would grow several crystals at different depths in the liquid.

In a bright light, reflection may occasionally be

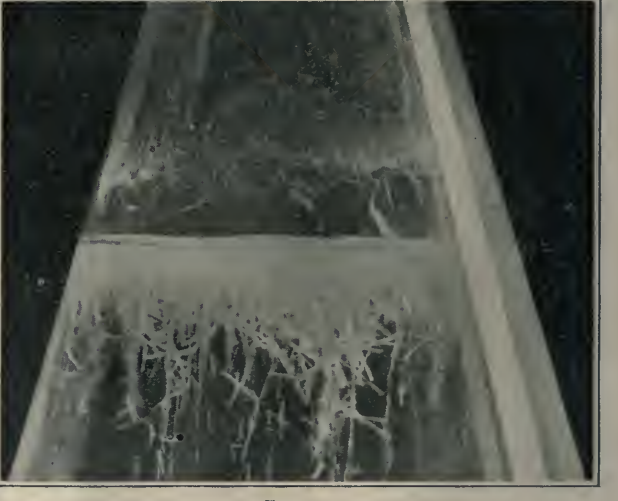

FIG. 1.

observed from some threads, but generally they are too small to be seen with the naked eye. They are elastic in the sense that, if the vessel is gently swung, the crystals oscillate at the end of their threads, which sometimes form flexible loops instead of hanging vertically. The threads are quite stable, as the suspension remains for months at a time. On one occasion the crystal layer was formed on a small grid of glass fibres and the solution syphoned out; the crystals were left hanging, but the threads could not be distinguished.

I am indebted to Mr. Sowerby of this College for the photograph.

C. R. BAILEY.

Chemistry Department,
University College, London, W.C.1,
June 8.

Studies from a Wireless Laboratory.[1]

By Prof. W. H. ECCLES, F.R.S.

THE studies pursued in a wireless laboratory are mainly of two kinds: first, those directed to the solution of problems that have arisen in the development or use of practical apparatus, and, secondly, those with which we are here concerned, aiming at the application of novel principles or novel physical phenomena to the invention of new methods or apparatus. Little will be said of the methods of wireless communication as they exist to-day; on the contrary, our attention will be devoted to some possibilities of wireless telegraphy—possibilities tested in the laboratory but not yet tried on the large scale. In other words, no attempt will be made to give a record of technical progress accomplished to date but, rather, to discuss wireless communication as it may be.

The new methods to be first described are based upon the phenomena, not yet fully known in detail, which occur when one vibrating body is caused to influence the vibrations of another. Consider the case of a simple pendulum consisting of a weight tied to the lower end of a string the upper end of which is held in the hand, and suppose it is of such a length that it would vibrate freely to and fro in a period of two seconds, when the hand is held still. Then it is easily

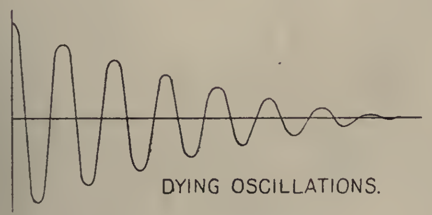

FIG. 1.—Dying oscillations.

seen that on moving the hand horizontally to and fro with a complete period of, say, one second, the pendulum will follow the hand and likewise vibrate with a period of one second. Similarly, when the hand vibrates with a period of, say, three seconds the pendulum will again follow and take the new period. This experiment is very familiar and is known to students of mechanics as an example of the subject of "forced vibration."

A pendulum forced in this manner may be said to vibrate "in time with" the hand, but the experiment shows that it is not "in step with" the hand. It would not be correct to say that it is "in tune with" the hand, since this term is reserved—in electrical physics at any rate—to indicate that the natural period of the free and unpropelled pendulum is the same as the period of vibration of the hand. We may, however, express the state of affairs by saying that the pendulum is forced into accord with the hand and that it is then in the "accordant state." A simple example of this relationship between two alternating movements is seen when a dog, for example, is walking along the road; his hind legs are in time but not in step with his fore legs.

The vibrations of a simple pendulum left free to vibrate with its own period gradually die down as indicated in Fig. 1. The vibration is a dying oscillation, and in such a case the theory of the forced vibrations is easily understood. In a modern wireless laboratory, however, we have to deal with growing and sustained vibrations as in Fig. 2, and in such cases the theory of the accordant state is rather different. This is to be expected—for it is like comparing a living thing to a dying one. Usually the vibrations are sustained by the aid of the triode valves so well known, and the rates of vibration are very high. In order to lead up to an understanding of the accordant state at these high frequencies it is best to study low frequencies first.

For the study of vibrations slow enough to be followed

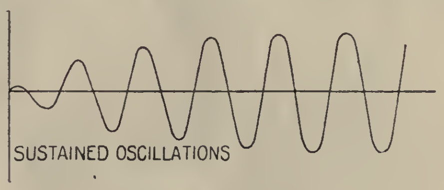

FIG. 2.—Growing and sustained oscillations.

by the eye a new type of oscillator has been designed and constructed and is here exhibited for the first time. Fig. 3 is a diagrammatic plan of the apparatus. The horizontal magnet has a horizontal ebonite rod fixed to it at right angles and the whole is suspended from a vertical torsion wire passing through the centre of gravity. The poles of the magnet confront two horizontal solenoidal coils connected in series with each other and with a battery and diode valve, that is, a thermionic valve of the type invented by Prof. Fleming in 1904 and containing only two electrodes, namely, a filament and a plate. Such a valve possesses the

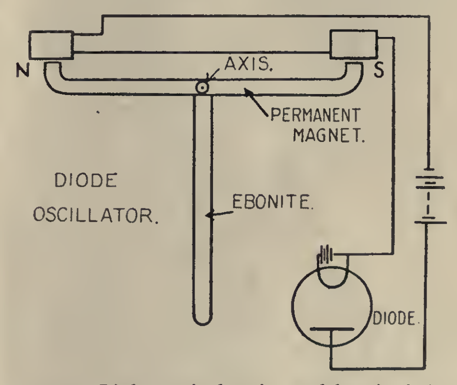

FIG. 3.—Diode-sustained torsion pendulum (in plan).

property that the electron current across the vacuum is sensitive to outside electrical influences if the electrodes have suitable relative positions—an ebonite rod charged by rubbing causes a diminution of the electron current when it approaches the diode and allows the current to increase again when it recedes. The action of this diode-sustained pendulum is now easily explained by supposing it swinging, and noticing that the ebonite rod as it moves to and from the diode causes an alternation of magnitude of the currents in and magnetic fields of the coils, which is automatically in correct time relation

[1] Substance of a discourse delivered at the Royal Institution, Friday, April 13.

to assist the motion of the magnet. By means of a small mirror fixed to the magnet, and a lamp and scale, the building up of the motion from a small initial amplitude is easily seen.

With two such pendulums the accordant state can be studied by eye observation. Dr. Winifred Leyshon is engaged upon this task. As arranged for the investigation one of the pendulums is made the master by sending some of its current through an auxiliary winding influencing the magnet of the other pendulum. The frequency of either the master or of the servant pendulum can be varied by the aid of a movable permanent bar magnet placed near the oscillating magnet. Then it is seen that as one natural period becomes nearly the

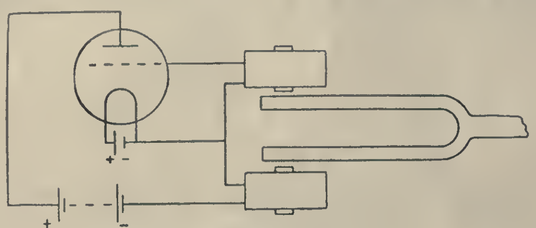

Fig. 4.—Triode-sustained tuning-fork.

same as the other the master catches hold of the servant, compels it to abandon its own natural period and to move in time with the master's—though not necessarily in step. The amount by which the servant is out of step depends upon the difference of the natural periods and therefore can be regulated.

These slow vibrations are seen and not heard ; but it is also possible to use vibrators of acoustic frequency and so make the according process evident to the ear. A tuning-fork sustained by a triode is very effective as the master oscillator. The circuit is shown in Fig. 4, from which it will be seen that when the fork is vibrating the induced electromotive force acting upon the grid controls the anode current so as to sustain the motion.

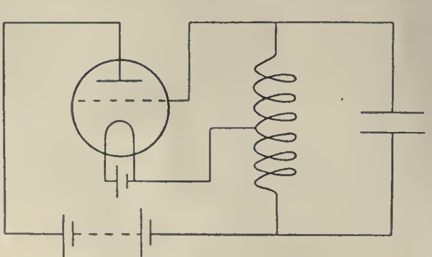

Fig. 5.—Triode electrical oscillator.

(See Eccles and Jordan, "Sustaining the Vibration of a Tuning-fork by a Triode Valve," The *Electrician*, June 20, 1919.)

On the other hand, an electrical oscillation, which is independent of moving matter, makes a good servant oscillator. Its circuit is shown in Fig. 5. The linkage between the two oscillators is effected by passing some of the current from the fork coils through an auxiliary winding on the electrical oscillator. The fork is audible when oscillating because it agitates the air; the electrical oscillations can be made audible by inducing currents in another circuit containing a loud-speaking telephone, and their frequency can easily be altered through a semitone or more by varying slightly the capacity of the condenser shown in Fig. 5. Now, as the natural frequency of the electrical oscillator is made to approach that of the fork, loud throbbings (called "beats") are heard, which become gradually slower until at a certain point the master suddenly drags the servant into time and the throbbings cease. If the movement of the condenser is continued the natural period of the electric oscillator is carried through resonance and then beyond, and finally the servant breaks away from the master and the throbbings indicating their difference of frequency begin anew.

This experiment is reminiscent of that of the two air-blown organ pipes discussed by the late Lord Rayleigh many years ago (*Phil. Mag.*, 1879, Collected Papers, vol. i. p. 409). Rayleigh showed that two organ-pipes nearly in unison dragged each other into a common frequency if brought into propinquity.

The preceding experiments have carried us from vibrations at 2 per second to vibrations at 200 per second ; we now pass to the problem of accordance when the vibrations are of frequency 200,000 per second, such as are commonly used in wireless telegraphy and telephony. Such high frequencies are neither seen nor heard, but can be detected by special methods. The electrical oscillator nsed comprises a triode and an inductance and capacity connected as in Fig. 5 and chosen of suitable magnitudes. The detecting apparatus is an inductance coil and variable condenser connected to a crystal detector just as in many a household crystal apparatus used for listening to the broadcasting stations. A galvanometer is connected to the crystal and a spot of light moves on the screen when the condenser is varied while the triode apparatus is in action. A maximum deflexion is soon found and then the receiver is in tune with the triode oscillator. Another triode oscillator is now substituted for the first and varied in frequency until in tune with the crystal receiver. Clearly both triode oscillators are now of approximately the same frequency. Let them both be put into action simultaneously so as to act upon the crystal circuit, and let a pair of auxiliary coils, connected in series, be placed confronting the respective triode oscillators in order to establish a linkage. The crystal circuit is receiving energy from both of the triode oscillators and actuates the galvanometer. The accordant state is then easily found by varying one of the oscillators very slowly and watching the spot of light. At the moment when the two oscillators come within a certain frequency difference, they suddenly pull into time and the spot of light gives a sudden kick. This phenomena was discovered by Dr. J. H. Vincent and described in the Physical Society Proceedings (p. 84, Feb. 1920). One of his curves is reproduced in Fig. 6.

This curve illustrates that as the condenser of one triode oscillator is increased the galvanometer in the crystal circuit shows first an increase and then a very sudden decrease of deflexion. The nearly vertical parts of the curve are due to the establishment of accordance. In a rough way one may explain the phenomenon by saying that at the lowest point of the curve, where there is a sharp cusp, the two oscillators though vibrating in time with each other are oscillating oppositely. In fact one oscillator is moving like the front legs and the other like the hind legs of the dog cited already. The curve or the experiment shows that

a very minute variation of the condenser of either oscillator makes the deflexion increase enormously.

There are several ways of applying this novel phenomenon to wireless telegraphy. Two of these may be illustrated here. Suppose one of the two oscillators to be a distant transmitter from which electric waves are proceeding, and that these waves are picked up by the antenna at a receiving station. Let the antenna be coupled to a local oscillator in the relationship of master, and let a tuned detector circuit be acted upon by both the antenna and the local oscillator. Then suppose the local oscillator adjusted until it is in the accordant state with the antenna oscillations, and, in fact, adjusted until the detector current is at the minimum value corresponding to the cusp of Vincent's curve (Fig. 6). It then follows that a very minute variation of the frequency of the oscillations emitted by the distant station will give rise to a deflexion of the galvanometer. It is suggested that signals could be transmitted by up and down changes in frequency—such changes would be far smaller than the changes of frequency employed by the accepted methods of the present day, and thus the interference between stations

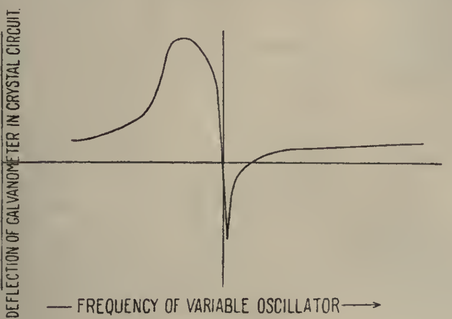

FIG. 6.—Vincent's curve.

would be minimised. There are many easy ways of producing small changes of frequency at the transmitting station.

Another and very different method of signalling may be illustrated by this same apparatus, after again adjusting the receiving apparatus to the minimum deflexion obtained in the accordant state. On trial it is found possible to bring the spot of light to any desired point of the scale—that is, to any desired point on the vertical portion of the Vincent curve—by appropriate adjustments of the frequency of the transmitting unit. These latter adjustments are for this purpose conveniently effected by the motion of a short circuited coil of wire near the inductance coil of the transmitting oscillator. Therefore, to every position of the auxiliary movable coil at the transmitter there corresponds a position of the spot of light actuated by the receiving apparatus. It might even be possible to mark the scales at each place with an alphabet and so communicate intelligence without the aid of the Morse code.

The above-described methods of signalling are based on the discovery of accordance between triode oscillators. Another distinct series of methods can be suggested and illustrated. These methods depend on the fact that the combination of two high-frequency electrical vibrations of slightly differing frequencies yields a throbbing amplitude which may be made of audible frequency and of any desired pitch by adjusting the frequency of either of the original vibrations. The formation of relatively slow throbbings from two quicker oscillations is shown diagrammatically in Fig. 7. The existing modern method of receiving continuous waves known as the heterodyne method utilises this principle in the following way: The transmitting station emits long and short trains of waves

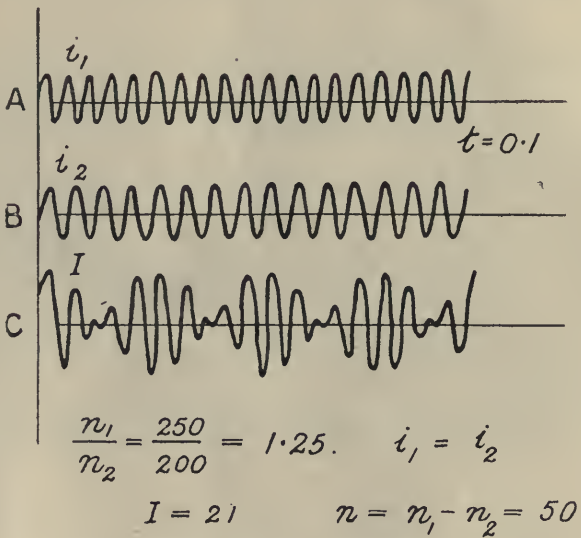

FIG. 7.—Illustrating the heterodyne method of reception.

corresponding to Morse dashes and dots and of frequency, say 200,000 per second. These waves produce in the receiving antenna feeble oscillations which are combined with locally generated oscillations of about the same strength and of frequency, say, 200,500 per second. The result is a compound high-frequency current with 500 throbbings in it per second. These when rectified can be heard in a suitably connected telephone. The long and short trains of waves from

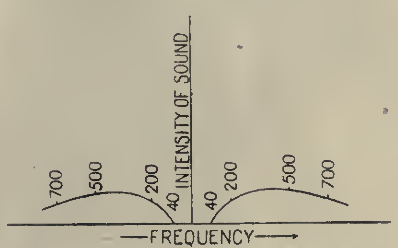

FIG. 8.—Diagrammatic representation of sounds heard in heterodyne reception.

the transmitting station thus give rise to sounds of long and short duration and of constant pitch. The pitch is adjustable by altering the local frequency from 200,500 to other values.

By altering this frequency from, say, 199,300 per second to 200,000 and then to 200,700 the sounds in the telephone run through a continuous scale of notes as represented in Fig. 8. This starts on the left with a note of 700 which falls in pitch to about 40 and becomes inaudible, passes through resonance, becomes audible again, and ascends a scale in opposite order to the first

scale. Thus a note of any desired pitch can easily be obtained, but the intensity varies on account of the varying sensibility of the ear and the apparatus. This possibility of variation of pitch makes a number of new methods of wireless signalling feasible. One of the easiest resembles a very early kind of moving needle telegraph apparatus called Bright's bells in which the needle moved to one side and struck a bell in order to indicate a dot and moved to the other side and struck a bell of different tone to indicate a dash. This method was faster than the dot and dash sounder and apparently easier to learn. In its proposed wireless form the transmitting station would emit equal wave trains to represent dots and dashes, say of 200,200 frequency to represent the dots and 200,500 frequency to represent the dashes. Each Morse sign is then heard as a little melody at a receiving station using a local oscillator of 200,000 frequency. Besides the advantage mentioned above there is a likelihood that these signals would be less distorted by atmospheric discharges than are longs and shorts of constant pitch.

Still another simple method consists in utilising three very close high-frequency oscillations at the transmitting station, say 200,200, 200,100 and 200,050, and making a new code for the alphabet out of permutations of these. The local oscillator would have a frequency of 200,000, and therefore the sounds heard in the telephone would be short tunes. The method would be faster than Morse, but might demand that the operators should have musical ears. Still another method can be imagined in which chords of three notes instead of arpeggios are used for the letters of the alphabet, but this might require an even more musical ear.

But there is one kind of chord which every one can recognise without special training, which even the horse can discriminate in the sounds of "whoa" and "gee." The vowel sounds are in fact chords. Lately Sir Richard Paget has given (Vowel Resonances, International Phonetic Association) a list of the chief tones occurring in the English vowels. For example, the vowel sound in the word "calm" contains the tones of frequency 1360 and 810 per second. Suppose, therefore, a transmitting station is arranged to emit simultaneously electric waves of frequencies 201,360 and 200,810, and suppose these waves when received at a great distance are combined with local oscillations of frequency 200,000 per second. Then the tones 1360 and 810 are perceived simultaneously as a chord in the operators' telephones. But this chord by itself is scarcely if at all recognisable as a vowel. Recognition is ensured by superposing a larynx note by aid of a buzzing contact included in the receiving circuit. Then whenever a train of two waves leaves the sending station the vowel is pronounced by the receiving apparatus. This is easily illustrated to an audience by the aid of a loud-speaking telephone. Lecture apparatus for producing and detecting the two vowel sounds represented by *o*, *a*, is shown in Fig. 9. The change of

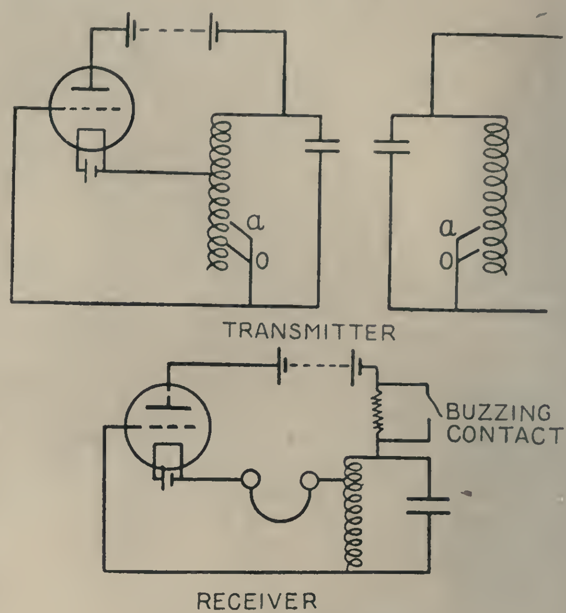

Fig. 9.—Heterodyne vowel apparatus.

radio frequency necessary for passing from one vowel to another is provided by the tappings on the inductance coils. In this apparatus the transmission occurs across a short distance; in practical telegraphy the transmitter would be more powerful and would be provided with an aerial and the receiving apparatus would also have an aerial.

The apparatus, which was built and made to work by Messrs. C. F. A. Wagstaffe and E. S. Smith, two former Finsbury Technical College students, was constructed to produce six vowels, namely, those heard in the words eat, all, hate, shoe, calm, and earth. These six vowels taken in pairs yield thirty-six symbols which, together with the five vowels *a, e, i, o, u* representing themselves, amount altogether to forty-one symbols. An alphabet formed in this manner is much briefer than the Morse code; that is to say, there are fewer efforts of the sending key in making the same message. For example, in the word London there are seventeen efforts when Morse is used but only eight when the vowel code is employed. Besides the gain in speed there is a possibility of reception through atmospheric disturbances being more easily accomplished with the vowel code than with the customary dots and dashes of constant pitch, but this can only be tested by actual trials.

Ur of the Chaldees.

By C. Leonard Woolley.

In 1919 Dr. H. R. Hall, on behalf of the British Museum, spent three months excavating at Ur. Last summer the British Museum and the University Museum of Philadelphia decided to send out a joint expedition which should continue for a term of years the work begun by Dr. Hall, and clear as much of the site as seemed likely to repay the necessarily heavy cost of a scientific mission. The first season's work of the joint expedition is now over, and the results amply justify the confidence of those who promoted it, and give every promise of even greater success in the future.

Mesopotamian sites are often on a very large scale, and though Ur cannot compare in this respect with Babylon, yet the mounds of the ancient city, spreading in length for some three and a half miles, afford a rather bewildering scope to the excavator. At Babylon, in the course of their eleven years of work, the Germans excavated a number of the most prominent mounds, with excellent results; but there is this drawback to the system, that we have in consequence a number of important buildings or groups of buildings isolated from one another, and can deduce from them very little regarding the lay-out of the town plan. At Ur it will take many seasons to obtain anything like a plan of the whole city, but luckily we are, even thus early in the day, able to learn a great deal about the most important element in the city—the "temenos" or sacred area wherein lay the principal temples and the palace of the king.

Dr. Hall had dug one section of the wall which enclosed this temenos. Last season we traced it for nearly its whole circuit and cleared four out of the six gates by which it was pierced. Inside it the great ziggurat or storied tower of brick is unmistakable, forming, even in its ruined state, a landmark visible for many miles. Dr. Hall excavated part of a building which we have identified as the sanctuary of the great temple of the Moon-god Nannar (the greater part of it has still to be dug). We have completely cleared a smaller temple dedicated to the Moon-god and his consort; and we have been able to fix with tolerable certainty the position of two other temples and of the royal palace. Already, therefore, we know not a little about the topography of the temenos; and as by means of air-photographs we have been enabled to trace, without digging, much of the main outer wall of the city, the problem of where work can most fruitfully be done is simplified to an unusual extent.

The temenos wall was built, as numerous clay dedication-cones inform us, by Ur-Engur, the king who founded the Third Dynasty of Ur about 2300 B.C. It is a hollow or compartment-wall, each wall being over 9 feet thick with 13-foot chambers in the interior. Built of unbaked mud brick, its face relieved by vertical double-rebated grooves, it still stands in places nearly 10 feet high (Figs. 1 and 2). But the existing brickwork is by no means all of the founder's date. Often in its long history it was patched or rebuilt, and in the gateways (where of course repairs were most frequently required) we find records of later restorers dating from Ur-Engur's own grandson, Bur-Sin, to Nebuchadrezzar, king of Babylon (600 B.C.), and Cyrus of Persia (*c.* 535 B.C.). Soon after Cyrus's time, perhaps in the middle of the 5th century, the temenos wall, with all the temples which it enclosed, was destroyed by Zoroastrian iconoclasts. In one of the gateways, last restored by Nabonidus, Cyrus's predecessor, the scorched brickwork and the charred beams of the gate-chamber roof survived as a testimony to religious intolerance. It was just inside this gateway that we found a headless diorite statue of Entemena, king of Lagash and of Ur about 2900 B.C.; it is probable that this ancient and already mutilated figure was unearthed by Nabonidus, who had a passion for archæology, and set up on the ziggurat in front of the gate.

FIG. 1.—Part of the buttressed outer wall of E-nun-makh, the temple of the Moon-god and his consort. The lower part was built by Bur-Sin (2250 B.C.), the upper part by Kudur-Mabug (2000 B.C.): the interior brickwork seen above is by Nabonidus, last king of Babylon (*c.* 550 B.C.). By courtesy of the trustees of the British Museum and the Board of the University Museum, Philadelphia.

FIG. 2.—Room in the sanctuary of E-nun-makh, the temple of the Moon-god and his consort, showing the old walls, the new floor of bricks laid by Nebuchadrezzar, the side altar with its offering-table, and the groove in the floor for the "chancel screen." By courtesy of the trustees of the British Museum and the Board of the University Museum, Philadelphia.

The temple of the Moon-god and his consort was a foundation far older than the temenos wall. When Ur-Engur repaired it, as he did, it had already been twice rebuilt, and the original builder is lost to us in the mists of antiquity. That the temple was in use by 2650 B.C. we know, for we found in it fragments of decorative stone vases dedicated by kings of Agade at that time—but probably it was venerable enough then (Fig. 3). Bur-Sin, the second in descent from Ur-Engur, thoroughly rebuilt the place; so did Kudur-Mabug (about 2000 B.C.) and Kuri-Galzu (four hundred years later); but then, and until another thousand years had passed, the form of the temple remained the same: like a human body regularly renewing its tissues, the old building was still itself though its bricks changed. So careful were the royal builders to keep to the old times that, as a rule, each left one or two courses of his predecessor's building *in situ* to serve as a guide to the new bricklayers, and as a result the lower parts of the walls which survive to-day sandwich into a few feet successive periods of history covering two and perhaps three thousand years. Nebuchadrezzar was the first to embark on a radical alteration. The original five-roomed sanctuary had been private, the god's own house, hidden away behind priests' chambers and stores and approached only by a winding passage. Nebuchadrezzar did away with all the service-rooms in front of the door, substituting for them a wide-open court with a smaller upper court whereon stood the altar. The alteration clearly points to a change from a secret ritual to public or congregational worship such as that referred to in the Bible story of the Three Children.

FIG. 3.—1, Votive alabaster mace-head of Ur-Engur (2300 B.C.). 2, 3, Votive alabaster mace-head and vase of Rim-mush, King of Agade (2650 B.C.). By courtesy of the trustees of the British Museum and the Board of the University Museum, Philadelphia.

The number of objects found in the course of the excavations was very great, including jewellery of the Neo-Babylonian and Persian periods, ivories and bronzes, hundreds of inscribed tablets, mostly of the time of the Third Dynasty (2300–2000 B.C.), terracotta reliefs, carved and inscribed stone vases, pottery, glass and stone beads, etc., etc. A special exhibition of these will be arranged at the British Museum as soon as possible, and illustrated lectures describing the progress of the excavations will also be given.

Current Topics and Events.

THE present outbreak of small-pox in Gloucester is very different from the tragedy of 1895–96. The number of cases in that frightful epidemic was 1981: and the number of deaths was 434. On the present occasion, the number of cases, up to now, has been about one-tenth of that number. As in other places, so in Gloucester, a very mild type of small-pox has appeared: indeed, so mild that, to some people, the very nature of small-pox seems to have changed. Still, the possibility remains that the disease will, some day or other, recover its old virulence. Besides, it appears that some of the Gloucester cases have been serious. Thus, at a meeting of the city council on June 27, the Mayor spoke of "some of the fearful sights" in the wards of the Isolation Hospital, and said that he should never forget them: and the chairman of the Health Committee spoke of "severe and ghastly" cases in the same hospital. Unhappily, so mild were the first cases that they were mistaken for chicken-pox. The best authority on the rules for avoiding this mistake between small-pox and chicken-pox is Dr. Wanklyn: and his writings are worth reading. The mildness of the epidemic, the controversy over its nature, the frequent concealment of cases, and the work of the anti-vaccinationists, have brought about a most unfortunate state of affairs in Gloucester. The fear is that Gloucester is steadily exporting small-pox to neighbouring towns.

THE first presentation of the Paterno medal was made on July 19 during the meeting of the International Union of Pure and Applied Chemistry in Cambridge. The chairman, Sir William Pope, explained that subscriptions had recently been collected to form a foundation to commemorate the many contributions made to chemistry in so many of its fields by Prof. Emanuele Paterno. It had been decided that the memorial should take the form of a gold medal to be awarded every three years for the most noteworthy discovery made in chemistry. Prince Ginori Conti, the president of the Italian Chemical Society, announced that at a recent meeting in Rome the committee appointed had unanimously nominated Dr. F. W. Aston as the recipient of the first award for his work in theoretical chemistry in connexion with the mass-spectrograph and isotopes. Prof. Paterno then presented the medal. Dr. Aston in replying expressed his sincere thanks for the great honour done to Cambridge and to himself by the award. He emphasised the importance of such international prizes as promoting goodwill between nation and nation, and expressed the hope that the distinguished chemist who made the presentation would be spared to assist at many similar occasions in the future. Although the work for which the award was made was almost entirely physical, he reminded the chemists present that his first published researches were in the domain of organic chemistry, and that to-day all definite distinction between physics and chemistry had been swept away by the discovery of the electrical constitution of matter.

NEWS of Mr. K. Rasmussen's researches in Arctic Canada have been published in the *Times* in a dispatch written in December 1922. The east coast of Melville Peninsula from Repulse Bay to Fury and Hecla Straits was charted, and extensive studies were made of the little-known Eskimo tribes in that region. These tribes, the Aiviliks and Igdluliks, have been largely influenced by the whalers who used to visit the coast in the latter half of last century. The whalers took the Aiviliks into their service as boatmen, finding them far superior for this purpose to the Eskimo of Greenland. The result was that the kayak fell into disuse and there are now no kayaks on this coast. Hunting sea animals plays a small part in the lives of these Eskimo, and the use of modern hunting gear, which alone is employed, will die out with the disappearance of the men trained by the whalers. Seal-hunting is not widely pursued, and consequently there is a shortage of blubber. In winter the snow huts are generally unheated, and Eskimo have to rely on good furs for warmth. Mr. Rasmussen found them hardy to an incredible degree. During summer many families move inland for trout-fishing and reindeer-hunting, but reindeer are scattered and not numerous. Hunting begins in July or August, which is the earliest time that the skins are fit for clothing. During the present summer Mr. Rasmussen, with one Eskimo companion, proposed to travel across Arctic Canada to Alaska and over Bering Strait to visit the Eskimo in Siberia. Other members of his expedition were to study the tribes of Melville Peninsula, and cross the interior of Baffin Land to the Hudson Bay Co.'s post on Home Bay. The result of all these researches promises to elucidate the problem of Eskimo origins.

ON Monday, July 2, the Prince of Wales opened the new anatomy, biology, and physics department of Guy's Hospital Medical School. The new building, which completes the rebuilding scheme started some twenty-seven years ago, consists of five floors. It provides accommodation for the teaching of embryology and histology in connexion with anatomy and for surgical research work, while close at hand is the new biology department. The transference of the physics department to the new building has provided increased space for the organic and biochemical side of the chemistry department.

THE twenty-fifth anniversary of the graduation, *honoris causa*, of Prof. F. A. H. Schreinemakers in the University of Leyden on July 7 is being marked by the issue of a special number of the *Recueil des travaux chimiques des Pays-Bas* which will contain more than sixty articles in English, French, German, and Italian by various colleagues, pupils, and friends, in Holland and elsewhere, of Prof. Schreinemakers. Copies of this number (price 8*s*. 6*d*.) can be obtained from Miss W. C. de Baat, Leyden (Holland), Jan van Goyenkade 30.

ACCORDING to the *Chemiker Zeitung*, Prof. A. Einstein has been elected a member of the order Pour le Mérite.

LORD CRAWFORD AND BALCARRES has been elected a trustee of the British Museum, in succession to Lord Rosebery, who has resigned.

IT is stated by the Ottawa correspondent of the *Times* that the Canadian Parliament has unanimously voted an annuity of 1500*l*. for Dr. Banting, the discoverer of the insulin treatment of diabetes, to enable him to carry on his scientific work.

THE French Association for the Advancement of Science is holding its annual meeting at Bordeaux on July 30-August 4. Communications regarding the meeting should be addressed to the secretariat of the Association at 28 rue Serpente, Paris, 6e.

PROF. F. GOWLAND HOPKINS has been awarded the gold medal of the Royal Society of Medicine, which is given triennially to a scientific worker, man or woman, "who has made valuable contributions to the science and art of medicine."

AT a meeting of the Royal Society of Edinburgh held on July 2 the following foreign honorary fellows were elected: Prof. E. B. Wilson, professor of zoology, Columbia University, New York; M. M. Boule, director of the Institute of Human Palæontology, Paris; Prof. A. F. Holleman, professor of organic chemistry at the University of Amsterdam; Dr. A. A. Noyes, Institute of California, Pasadena; Prof. T. W. Richards, professor of chemistry, Harvard University, Cambridge, Mass.; Prof. Tullio Levi-Civita, professor of mathematics (higher analysis) at the University of Rome; Prof. Henri Bergson, honorary professor of the College of France; and M. Alfred Angot, late director of the Central Bureau of Meteorology, Paris.

AT the annual general meeting of the Röntgen Society on June 5, the following officers were elected :—*President* : Sir Oliver J. Lodge ; *Vice-Presidents* : Sir Ernest Rutherford, Dr. A. E. Barclay, and Dr. F. W. Aston ; *Hon. Treasurer* : Mr. G. Pearce ; *Hon. Editor* : Dr. G. W. C. Kaye ; *Hon. Secretaries* : Dr. E. A. Owen, Mr. R. J. Reynolds ; *Council* : Mr. C. Andrews, Dr. G. B. Batten, Lt.-Col. Kenelm Edgcumbe, Mr. N. S. Finzi, Mr. W. Hope-Fowler, Dr. F. L. Hopwood, Dr. J. E. A. Lynham, Mr. G. H. Orton, Prof. A. W. Porter, Prof. S. Russ, Dr. R. W. A. Salmond, and Mr. W. E. Schall.

IN the report of the council of the British Medical Association it is stated that the British Medical Association in Australia has instituted a gold medal for the purpose of perpetuating the appreciation of services rendered by members of the British Medical Association in Australia. The medal has on one side the figure of Æsculapius in relief, and on the obverse a wattle wreath, with the wording "The British Medical Association in Australia," "For Distinguished Service," with loop and ribbon of royal blue. It is to be presented at the congress of the British Medical Association in Australasia to be held in Melbourne in November, and the first recipients will be Dr. R. H. Todd and Dr. W. T. Hayward.

A SUCCESSFUL "commemoration day" was held at Livingstone College on June 13, Sir Leonard Rogers being in the chair. Various speakers testified to the benefit of the training received at the College, which is designed to give to missionaries the elements of medical knowledge. The College would be self-supporting if a sufficient number of students were sent to the College regularly, but at present this is not so, and about 500*l.* is urgently needed.

THE Marlborough College Natural History Society has long been prominent in maintaining an interest in field-studies, and through them in the essential beauty of the earth, among those who otherwise might grow up on the old conventional lines of public-school education. The report for 1922 (Marlborough : the *Times* Offices, 1923) records the proceedings of a number of sections, including those of astronomy and archæology ; the latter is carrying out actual excavations on the site of Castrum Merlehergæ (pp. 37-45). The botanical section has added two new species to the local list during the year. Perhaps the most striking signs of activity are the geological excursions taken in Scotland, during which the members were very kindly guided by Mr. G. W. Tyrrell, lecturer in the University of Glasgow, over ground dealt with in his own researches. Mr. A. G. Lowndes (p. 57) gives a lucid account of the conditions under which the pitchstones of the dykes in the Isle of Arran were formed, and this is accompanied by a plate of thin sections as seen under the microscope. The other photographic illustrations, including birds' nests in their natural surroundings, add much to a stimulating production. We are sure that members of this firmly established Society carry the memories of its field-days to their more ambitious journeys on *safari* in Kenya, or in dug-outs on Malayan seas.

THE University of Chicago Press, Chicago, Illinois, has just issued a third edition of its very useful illustrated catalogue of astronomical photographs. The photographs have been reproduced mainly from negatives taken at the Yerkes Observatory, and have been issued for the convenience of the general public, the man of science, the student, and the lecturer. They comprise lantern slides, transparencies, and prints, issued at uniform prices ; but, at an extra cost, they may be obtained modified in size or other qualities, to meet individual needs. Card descriptions of the lantern slides also are published. The photographs appear to cover the whole range of observational astronomy, and include, in addition, a number of views of astronomical instruments and portraits of famous astronomers of the past and present. There are, finally, a few stereograms, chiefly of the moon, planets, and comets. A large number of the photographs were taken by the late Prof. Barnard, among which his well-known and beautiful pictures of the Milky Way and of dark markings in the sky are particularly welcome. Of great value to teachers and lecturers are the photographs of stellar spectra, with terrestrial comparison spectra, illustrating the Doppler displacements due to relative motion of the star and the earth in the line of sight. Reproductions of two of these photographs are given in the catalogue ; they show the effect with unusual clearness and beauty. It would have been a great boon to teachers of astrophysics if the publishers had found it possible to include a complete series of typical spectra, in the visible region, of the various Harvard types. Only the violet and ultra-violet regions are now accessible. The catalogue should prove extremely useful to all who are interested in any way in the observation of the heavens.

THE Manila Weather Bureau sets a praiseworthy example to many larger institutions in the comparative promptness—judged by post-War standards—with which it issues its volume of magnetic observations for the calendar year 1919. Until 1904 the observatory was at Manila, whence it had to be removed, on account of electric tramway disturbances, to Antipolo, twelve miles distant from the city. It started its new career in 1911, and its annual reports have since then been modelled on the pattern adopted by the U.S. Coast and Geodetic Survey. Hourly values of declination and horizontal and vertical magnetic force are given, together with the daily mean, maximum, minimum, and range for each element. Mean diurnal inequalities are given for each month and for the five quietest and five most disturbed days per month. These inequalities are also summarised in separate tables : the inclusion of a table of daily variation of the total force might perhaps be dispensed with.

A USEFUL pamphlet published by the United States Coast and Geodetic Survey (Special Publication No. 93, price 30 cents) deals with Reconnaissance and Signal Building. The author, Mr. J. S. Bilby, writes from experience of actual cases arising in the routine of field work, and dwells on the practical

difficulties that are encountered in a preliminary reconnaissance for precise triangulation. The first part of the publication discusses the character and strength of triangulation figures, selection of sites, and intervisibility of stations. The second part deals with signal building, and includes practical directions, with detailed plans and specifications. The section on hydrographic signals is specially interesting. Signals of some kind or other, either ashore or afloat, are frequently necessary in the location of soundings off a low flat coast. Full plans and illustrations and a note of the amount of material required are given.

THE third number of volume i. of the *Japanese Journal of Botany* has just been issued by the National Research Council of Japan. In addition to botanical papers, it contains reviews of the current Japanese botanical literature, much of which is published only in Japanese and has hitherto been unavailable to workers in other countries. This is therefore a valuable feature of the Journal, and should be of much service in making more widely known the work of Japanese botanists. The present number contains papers in English and German, chiefly on genetical subjects, as well as abstracts of the principal botanical papers which have appeared in Japan during the period April-September 1922.

M. MARCELLIN BOULE, the eminent French anthropologist, in the Huxley Memorial Lecture for 1922, published in the Journal of the Royal Anthropological Institute (vol. lii., 1922), describes the services rendered to the study of man by the late Prince Albert I. of Monaco. The Prince, impressed by the importance of the remarkable cave records in southern France, devoted much attention to the development of these discoveries, of which M. M. Boule gives an interesting account. One important result of his work was the establishment of the Institute at Monaco, where the treasures recovered from the caves find a suitable home, and where the study of them can be conducted.

Our Astronomical Column.

D'ARREST'S COMET. — This interesting periodic comet is due at perihelion in two months, and its detection in July may be hoped for, as it is well placed in the evening sky. Mr. F. R. Cripps has calculated the perturbations by Jupiter and gives the following elements and ephemeris (for midnight) in B.A.A. Journal for May:—

$$T = 1923 \text{ Sept. } 14{\cdot}12 \text{ G.M.T.}$$

$$\left.\begin{array}{l} \omega = 174^\circ\ 7'\ 15'' \\ \Omega = 143\ \ 32\ \ 18 \\ i = 18\ \ 3\ \ 47 \end{array}\right\} 1925{\cdot}0 \qquad \begin{array}{l} e = 0{\cdot}6169 \\ \log a = 0{\cdot}5478 \\ \log q = 0{\cdot}1311 \end{array}$$

	R. A.	N. Decl.	log r	log Δ
July 8.	16h 26·0m	12° 19′	0·193	9·856
,, 12.	16 25·2	11 6		
,, 16.	16 25·2	9 42	0·181	9·847
,, 20.	16 26·1	8 8		
,, 24.	16 28·1	6 24	0·170	9·841

The comet is nearest to the earth at the end of July and brightest in mid-August. The moon will cause difficulty in the latter part of July. The positions given above lie in the southern part of Hercules, and are nearly due south at the end of twilight.

There is no further confirmation of the announcement of the discovery of a comet by Abbot at Athens.

THE COMING OF THE PERSEIDS.—Mr. W. F. Denning writes: "Early meteors from the great August shower are occasionally visible at the beginning of July. They should be carefully observed, as it is desirable to ascertain the opening date of the display. A few meteors, if observed at two stations, might satisfactorily settle the question, though, at its first oncoming, the shower is but slightly manifested. This year there will be no moonlight to interfere with the maximum on about August 11 or 12, and with clear weather the event should be witnessed under good conditions. There is no reason for expecting that the ensuing return will be one of very rich character, but the Perseids form an annual spectacle of meteoric activity not equalled by any other system. A maximum of special intensity was witnessed on the morning of August 12, 1921, when the hourly number of meteors visible to an observer was 250. There is evidence to show that the shower presents itself most richly at intervals of 11·75 years, but more observations are required. Its duration continues over the two summer months of July and August.

"The Perseid shower will be supplemented by other radiants, the following being among the more prominent ones visible at or from about the middle of July and, in certain cases, for some time afterwards:—

16° +31°	47° +44°	303° − 10°	334° +73°
22 +21	270 +47	303 +24	335 +58
25 +43	292 +53	312 +62	339 − 12
42 +22	281 +44	315 +48	343 +12

There are certainly more than 100 different systems in play, but the great majority of them are feeble and apparently the relics of nearly exhausted streams which possibly formed rich displays in ancient times."

PERTURBATIONS OF THE MINOR PLANETS.—Prof. A. O. Leuschner has published a useful report on this subject as a Bulletin of the Research Council of the National Academy of Sciences, Washington. It deals with twenty-three interesting planets, including the four bright ones, Eros, Andromache, and the six Trojan planets. Tables are given of all orbits published, with a statement of the method by which they were derived.

It is obvious that the vast host of minor planets can only be observed efficiently if there is a methodical division of labour. Arrangements for this had been made before the War, which threw them into confusion, and it is welcome news that Prof. Leuschner's Bureau is again making arrangements for this purpose. At present planets that are better known are frequently observed to an unnecessary extent, while others are neglected. Marseilles Observatory has published numerous orbits and ephemerides of late years, but it has not been in touch with all the countries where observations were being made. One point emphasised in the report is the importance of giving clear information in all published orbits of the materials that were used in obtaining them, and the perturbations that were applied. Several cases are quoted in which this information is lacking.

Research Items.

AN EGYPTIAN STATUE OF MENKAURA IN LONDON.—In *Ancient Egypt*, 1923, part i., Prof. Flinders Petrie describes a remarkable figure in white alabaster, acquired some time ago for University College, London. It shows a further development of the great Khofra statue. There the king's head is shielded by the falcon's wings which are spread out behind the head-dress; here the king is himself the falcon god, entirely human in front view, entirely bird-like at the back. The lower part is incomplete, but the figure was probably seated. The resemblance to the *bourgeois* figure of Menkaura is obvious at first sight; and the development of the protecting falcon would accord with this representing the successor of Khofra. It can scarcely be questioned that it came from one of the two temples of Menkaura.

EXCAVATIONS IN UPPER SIND, INDIA.—A dispatch from the Bombay correspondent of the *Times*, published in the issue of June 25, summarises a report of excavations in Upper Sind carried out by Mr. R. D. Banerji, of the Indian Archaeological Survey, on the ruins of an ancient city now known as Mohenjidaro or Mohenjodhari, six miles from Dokri on the North-Western Railway. The highest mound in these ruins, which cover more than two hundred acres, was selected for excavation. It proved to be a Buddhist shrine on an artificial platform situated on an island in the old bed of the Indus. This platform was protected from the effects of high floods by retaining walls some 40-50 feet high. Two more mounds excavated produced remains of shrines dating from the second century A.D. during the reign of the great Kushan Emperor Vasudeva I., A.D. 158–177. A stratum below the shrine contained what were apparently the remains of an older shrine which had been burnt, possibly by Scythian invaders. There are two most interesting features in these investigations. The first is the discovery of a number of coins representing the earliest copper currency of North-Western India, and differing from any discovered hitherto in India in being dye-struck and not punch-marked. These coins also afford the oldest representation of the Fire-Altar of the ancient Persian religion on Asiatic coins, and furnish evidence that this religion and Buddhism flourished side by side. The second point of particular interest is the discovery in one group of coins of inscriptions in unknown characters, as yet undeciphered, which it is maintained are hieroglyphs or ideograms differing from Egyptian hieroglyphs. This is claimed to be the only recorded discovery of a new type of hieroglyph in Asia; but Sir J. Marshall, Director-General of Archæology in India, has since pointed out that these pictographs are similar in character to those from Harappa in the Punjab.

DISCOVERY OF A MIDDEN AND FIRE-HEARTH AT CHARK, NEAR GOSPORT.—In the June issue of *Man*, Lieut.-Colonel J. H. Cooke describes the result of excavations on Chark Common, about one mile from the shores of Spithead. They included a midden and camp fireplaces which were coeval. The midden is unique of its kind, though it is not as large as some of the great shell-heaps on the Continent, but it is the only example of a midden in Britain in which the contents are unmixed with relics of later cultures. Its principal features are the character of the deposits in which it is embedded, the many species of shells it contains, the well-marked types of implements found in it and around the adjacent fire-hearths, and the total absence of any fragments of pottery or metal. It is attributed to the Robenhausen period of the Stone Age, which immediately preceded the Bronze Age.

FOSSIL CRABS FROM HAITI.—Some Brachyuran Crustacea from the Pleistocene and Miocene deposits of Haiti form the subject of a short paper by Miss Mary J. Rathbun (Proc. U.S. Nat. Mus., vol. lxiii. art. 9). One genus, Mithrax, which is widely distributed throughout the West Indies, had not before been found fossil, but is now recorded from the Pleistocene.

MESOZOIC INSECTS OF QUEENSLAND.—Fossil remains of insects are not usually found associated in great abundance at any one spot, so that the discovery of a six-inch seam full of such remains, and that from so low a geological horizon as the Trias, is a noteworthy occurrence. The layer in question was disclosed at Denmark Hill, Ipswich, some few miles west of Brisbane, Queensland, and the description of its insect contents has been undertaken by Dr. R. J. Tillyard and Mr. B. Dunstan. The first part, just issued, is by Mr. Dunstan (Queensland Geol. Surv. Publication, No. 273), and deals with introductory matter and the Coleoptera of the deposit. After describing the section from both the physical-geographical and the geological aspect, the author is tempted to speculate on the cause of the wholesale destruction of insects here manifest. From a study of the phenomena occurring at the hot springs at Einasleigh, Northern Queensland, where the edges of the pools are lined with myriads of wings and elytra, from which the soft parts have evidently been removed by the hot bubbling water, while insect fragments float about and then disappear down the stream, Mr. Dunstan infers that similar conditions governed the formation of the Triassic deposit. The major portion of the paper is devoted to full and careful descriptions of the fifty-eight species, belonging to twenty genera, the bulk of which are of course new, referable to some eight families. The Hydrophilidæ are the most numerous. One could have wished, however, that the seven plates had been executed in a style more consonant with the rest of the work.

A NEW GRASS.—In the *Kew Bulletin*, No. 5 of 1923, D. K. Hughes describes and figures an interesting grass, *Streptolophus sagittifolius* Hughes, which has been grown at Kew from fruits received from Mr. J. Gossweiler, director of the Botanic Garden, Angola. Conspicuous features of the new genus are the sagittate leaf blades, lifted away from the leaf sheaths upon slender petioles which are set at a sharp angle to the main stem, and the flowering panicles, which owe their characteristic appearance to the fact that the branchlets are reduced to slightly flattened bristles which are fused at the base into clusters.

EARTHQUAKES AND PHEASANTS.—Pheasants, it has long been known, are peculiarly sensitive to the effects of slight tremors, and in many earthquake countries they are supposed to give notice of a coming shock. Prof. Sekiya's attempt, nearly forty years ago, to study the behaviour of pheasants before and during earthquakes was unsuccessful, probably because the birds were not under natural conditions. Recently, Prof. Omori (Bull. Imp. Earthq. Inves. Com. of Japan, vol. 11, 1923, pp. 1-5) has been able to observe those living in a neighbouring park, usually within a distance of a hundred yards, and

during the quiet hours of the night. In three years he recorded 22 cases of the disturbance of pheasants. On seven occasions the birds crowed before the tremor was felt, on five at the same time, and on five afterwards. In four cases they crowed while no tremor was felt, though slight movements were recorded by the seismographs; and in only one case did an earthquake occur without the accompaniment of pheasant-crowing. Thus, in half the cases observed, the movement was noticed by pheasants more readily than by a trained observer under good conditions.

NORTH SEA FISHERIES IN 1920–22.—There was something unusual in the physical conditions of the North Sea in 1920–22. A much greater influx of Atlantic water occurred, and the pelagic fauna showed marked deviations from its normal character. The pelagic tunicate, Salpa, appeared in great numbers, and there were swarms of medusæ in regions where they had not usually been seen in quantity. The herring fishery of 1921 was very poor, both as regards the catches made and the quality of the fish. The latter were ill-nourished, and this may be regarded as an indirect effect of the changed physical conditions. Several papers that have appeared recently provide data for a treatment of this remarkable hydrographic occurrence. *Rapports et Procès-Verbaux*, vol. xxix., published in May by the International Council for Fishery Investigations, gives the first report of a committee formed to investigate the Atlantic slope W. and S.W. from the British Isles, and hydrographic and planktonic results for the year 1921 are recorded. *Publications de Circonstance*, Nos. 78, 79, and 80, also published by the Council (in April), contain papers by A. C. Hardy, J. N. Carruthers, and J. R. Lumby, dealing with the plankton, the non-tidal movements of North Sea water, and the salinity and temperature of the southern North Sea and English Channel during 1921. The results are interesting and of importance for a consideration of the causes of the unusual conditions of the North Sea mentioned above. That inadequate food-supply does not completely explain the failure of the herring fishery of 1921 is apparent from results obtained by Mr. B. Storrow (Report of the Dove Marine Laboratory, Cullercoats, Northumberland, for 1922). There was an actual shortage of fish having three winter rings on their scales; this result was obtained from a great number of careful measurements made at Cullercoats. Therefore, whatever happened to make the fishery a failure happened about 1917 as well as in 1921. The failure characterised the North Sea fishery but not that of the Firth of Clyde, and there the 1917 year class of fish was well represented.

CONSTITUTION OF DOLOMITE.—Dolomite has always been regarded by mineralogists as a definite compound, $CaCO_3,MgCO_3$, the reason for this conclusion being apparently the very constant composition of different specimens of the mineral from various parts of the world. The suggestion has recently been made by Spangenberg that the mineral is a solid solution of calcite and magnesite, the limits of miscibility being placed between the proportions $CaCO_3,2MgCO_3$ and $2CaCO_3,MgCO_3$. The substances prepared by him, however, have not the properties of dolomite. The matter has recently been investigated by Mr. A. E. Mitchell, at the suggestion of Prof. Donnan, and the results of some preliminary experiments are given in the May issue of the Journal of the Chemical Society. The dissociation pressure curves of calcite, magnesite, and dolomite have been determined from 700° to 1200°. In the case of calcite it is shown that the equation of Nernst is in good agreement with the results, the more complicated equation of Johnson being not only unnecessary but inaccurate. The curve for dolomite lies about half way between those of calcite and magnesite. Some measurements of the specific heats were made, in order to apply the Nernst equation, and an attempt to measure the heat of formation of dolomite gave the small value of 4·52 kg. cal. per mol. It is concluded that the dissociation of dolomite occurs according to the equation $CaCO_3,MgCO_3 = CaO,MgO + 2CO_2$. The experiments have not, however, been carried far enough to enable a decision to be made as to whether dolomite is a compound or a solid solution.

MOISTURE IN FRESHLY FELLED TIMBER.—In the Notes of the Royal Botanic Garden, Edinburgh, for January 1923, Prof. W. G. Craib has a third paper upon the "Regional Spread of Moisture in the Wood of Trees." As described in the earlier papers, specially selected trees are carefully felled and sections of timber taken for investigation, moisture determinations being separately carried out for blocks at different depths right across the section; this process is repeated at different levels and the results expressed graphically. This interesting line of research not only provides data of great practical interest to the forester, but also contributes to our knowledge of the ascent of sap in trees. Prof. Craib has previously shown that in winter there appears to be considerable storage of sap in the heart-wood of *Acer Pseudoplatanus*, the sap moving outwards later until it is mainly in the outer ring of young wood as the transpiration current becomes active in the summer. The present paper demonstrates a somewhat similar but slower change of sap distribution in the wood of the holly, while in resinous conifers no storage of sap in the heart-wood takes place, probably because the resin hinders radial migration of the sap. In the non-resinous yew tree there is again a storage of sap in the heart-wood. A very interesting plate shows the distribution of sap in a tree of *Populus trichocarpa*, felled on a windy day. In the sapwood on the side towards the wind there is the usual high percentage of moisture, but on the side away from the wind it has fallen very low. Prof. Craib's further papers will be awaited with interest, and there will be general congratulations from his colleagues that this paper seems to show him well on the way to a full renewal of the scientific activities so severely interfered with by his accident at the time that the British Association met in Edinburgh.

EWING'S NEW FERROMAGNETIC MODEL.—In our issue for March 9, 1922, p. 321, we gave an account of the new model of an atom of a ferromagnetic material proposed by Sir Alfred Ewing as an improvement on that brought forward by him in 1890. A portion only of the atom was taken as capable of alignment with the external field, and the controlling force on this part was considered to be due in the main to the fixed portion of the atom. In the February issue of the Science Reports of the University of Sendai, Profs. Honda and Okubo examine the new theory, and show that it is not in agreement with the discontinuous changes of magnetic properties which are found in steels during heating and cooling between 700° and 730° C., nor with those found in pure iron at 910° and 1410° C. respectively. They conclude that the quantitative extensions of the older theory made by them in 1916 and 1917 reproduce the hysteresis loop and the effects of temperature on magnetisation much more accurately than does the new theory.

The Pasteur Centenary Celebrations.

THE national celebrations which took place throughout France on May 24 - June 1 in honour of Louis Pasteur are unique in history, for never before has such a splendid tribute been paid to the memory of a man of science.

The invitations to attend the celebrations were issued jointly by the rector and council of the University of Paris and the rector and council of the University of Strasbourg. The celebrations began on May 24 in Paris with an evening reception tendered by the President of the Republic at the Palace of the Élysée, where a large and distinguished company consisting of diplomatic and scientific representatives from practically all parts of the world were assembled.

On the morning of May 25 Dr. Roux and his colleagues at the Institut Pasteur held a reception, after which the visitors defiled before the tomb of Pasteur, which was decked with floral tributes. Among these, there being many, may be mentioned the wreaths sent by the British Government and the Royal Society, the latter resting at the foot of the monument. Afterwards bronze commemorative medals were distributed among the guests, who had signed their names in a volume which will afford a valuable record of the occasion. Driving homeward along the Boulevard Pasteur, the vehicles conveying the guests halted for a short time in the Place Pasteur before the beflagged monument of Pasteur. In the afternoon the British delegates were summoned by invitations from the University of Paris and Association France-Grande-Bretagne to the "Salle des Autorités" at the Sorbonne, where a tablet commemorating the meeting of Lister and Pasteur was unveiled and the British Ambassador made an appropriate speech. Immediately thereafter followed the ceremonial gathering in the Grand Amphitheatre of the Sorbonne, about 2700 persons being assembled, in the presence of M. Alexandre Millerand, President of the Republic (Chairman), M. Paul Appell, rector of the Paris Academy and president of the council of the University of Paris, Government and academic representatives and others, the picture afforded being most impressive and recalling that painted by Rixens in commemoration of Pasteur's Jubilee in 1892, fine colour effects being afforded by the many academic robes and uniforms. The ceremony began with the singing of the Marseillaise by a large choir of girls to the accompaniment of the band of the Garde Républicaine, the whole audience standing at attention. M. Paul Appell, M. Léon Bérard (Minister of Education and Fine Arts) delivered speeches and were followed by the Papal Nuncio, who conveyed the Pope's blessing on the occasion. As Government delegates, Prof. W. H. Welch spoke on behalf of the United States and Sir Charles Sherrington on behalf of the British Empire; delegates from other countries followed, most of them reading speeches in a French that was difficult to follow. Finally M. Strauss, Minister of Hygiene, delivered an impassioned speech after the foreign delegates had severally presented congratulatory addresses on behalf of various universities and learned bodies, these being handed over unread with no semblance of order. Addresses were presented from the Universities of Oxford, Cambridge, Edinburgh and Liverpool, the Royal Colleges of Physicians and Surgeons of London and Edinburgh, and numerous other bodies.

On May 26 were issued postage stamps (values 10, 30, and 50 centimes) bearing the portrait of Pasteur. A reception was held at the École Normale by M. Gustave Lanson, the director, and the guests were shown the "Cabinet Pasteur" with its interesting mementoes of Pasteur's sojourn and activities at that institution. M. Lanson read out a hitherto unpublished letter of Pasteur's addressed to the French Ministry appealing for financial aid in the prosecution of his researches. This letter revealed the personality of Pasteur in a remarkable manner, his clearness of thought and marvellous prescience being strikingly exhibited; the whole audience was thrilled and felt that M. Lanson's opening words, that he was "about to let Pasteur himself speak to the audience," were indeed justified. It is to be hoped that the letter will soon be published. The company next walked to No. 10 rue des Feuilleantines close-by, to witness the unveiling of a tablet upon the house where Pasteur lived as a student, and, finally, in the evening, a reception was given at the Hôtel de Ville by the Municipality of Paris. Here, as at the Élysée, there were representations by artists of the Comédie Française, and Opéra, etc., the recitation of two of Pasteur's speeches by M. Léon Bernard, of the Comédie, invoking much enthusiasm among the hearers. The speeches were those delivered by Pasteur (*a*) at Dôle in 1883, when a tablet was affixed to the house in which he was born, and (*b*) at the Sorbonne in 1892, on the occasion of his jubilee. An eloquent passage from the latter speech was frequently quoted by orators in the days that followed, and it may well be cited here from a printed copy which was thoughtfully distributed to the guests at the centenary celebration:

"Jeunes gens, jeunes gens, confiez-vous à ces méthodes sûres, puissantes, dont nous ne connaissons encore que les premiers secrets. Et tous, quelle que soit votre carrière, ne vous laissez pas atteindre par le scepticisme dénigrant et stérile; ne vous laissez pas décourager par les tristesses de certaines heures qui passent sur une nation. Vivez dans la paix sereine des laboratoires et des bibliothèques. Dites-vous d'abord: Qu'ai-je fait pour mon instruction? Puis, à mesure que vous avancerez: Qu'ai-je fait pour mon pays? jusqu'au moment où vous aurez peut-être cet immense bonheur de penser que vous avez contribué en quelque chose au progrès et au bien de l'humanité. Mais, que les efforts soient plus ou moins favorisés par la vie, il faut, quand on approche du grand but, être en droit de dire: J'ai fait ce que j'ai pu."

On Sunday, May 27, the Lycée Pasteur was inaugurated in the morning. In the afternoon l'Accueil Franco-Britannique and Dr. and Mme. Tuffier received the British delegates in the charming home of the latter, which, we may mention incidentally, contains a fine collection of pictures. In the evening there were gala representations at the Opéra and Théâtre Français in honour of the foreign delegates. Throughout France, ladies and schoolgirls collected money for the scientific laboratories of the country, some ten differently designed badges, mostly bearing the effigy of Pasteur, being pinned with the tricolor to persons who helped by contributions. All the badges were inscribed on the back with the words: "Journée Pasteur, mai 1923. Au profit des Laboratoires," and a quotation from Pasteur reading: "Sans laboratoires les savants sont des soldats sans armes."

On May 28 the guests were conveyed to the Palace of Versailles, where a banquet was held in the "Gallerie des Batailles," some 900 persons participating under the presidency of M. Reibel, Minister of the Liberated Regions. The latter, in his speech, cited with special emphasis Pasteur's advice to men of science: "Luttons donc dans le champ pacifique de la science pour la prééminence de nos patries respec-

tives. Luttons, car la lutte c'est l'effort, la lutte c'est la vie, quand la lutte a le progrès pour but," adding that it was surely necessary that Pasteur's pronouncement should be repeated "in this Palace with its many significant associations." M. Reibel's speech was followed by those of diplomatic representatives which could not be heard by many because they were delivered across the centre of the very long gallery.

On May 29 some of the guests attended a morning presentation of the cinematograph film entitled "Pasteur" designed to popularise his work. In the afternoon the Institut de France held a garden party at Chantilly, the castle with its art treasures being thrown open for inspection.

Many left Paris on May 30 to attend the concluding ceremonies at Strasbourg, where in the evening a reception was held in the Palais du Rhin.

On May 31 a monument of Pasteur was inaugurated in front of the University of Strasbourg in the presence of the President of the Republic accompanied by M. Poincaré (Prime Minister), M. Strauss (Minister of Hygiene), M. Valery-Radot and others, academic dress being worn by University representatives, a few of whom presented addresses to the University which they delivered into the President's hands. Orations were delivered by M. Charléty (rector of the University), M. Haller (president of the Academy of Sciences), Prof. Bordet (Pasteur Institute, Brussels), and finally M. Millerand spoke with the eloquence of a practised orator in a voice that carried far, his speech being remarkably good. There followed a banquet at noon attended by some thousand persons at the Palais des Fêtes under the presidency of MM. Millerand and Poincaré,. speeches that were more or less audible being delivered by the Mayor of Strasbourg, M. Alapetite (Commissioner General of the Republic), M. Strauss, and others. Following upon the banquet the company assembled at the Palais du Rhin, the ex-Emperor's former palace, to witness the procession of Alsatian Societies before the President; it was a stirring sight, which deeply moved all beholders, to see the representatives from all parts of Alsace and Lorraine, lads and maidens dressed in the characteristic costumes of their districts stepping along briskly hand in hand to the music of numerous bands that accompanied them, while a deeper note was struck as veterans of the War and of the war of 1870 defiled past, all saluting the President of the Republic. There followed the opening ceremonies at the Pasteur Museum and the International Exhibition of Hygiene and an evening reception at the Hôtel de Ville given by the Mayor of Strasbourg. Speeches were made in connexion with these ceremonies, those delivered by Prof. Borrel (Commissary General of the Exhibition) and M. Poincaré being the most notable. The scene at the Hôtel de Ville was remarkable when, from the balcony, M. Millerand addressed the populace assembled in the square and twenty thousand people with upturned faces sang the Marseillaise to the accompaniment of massed bands; it was a sight which none who witnessed it can forget.

The Comité du Centenaire de Pasteur was responsible for all arrangements and, except in minor matters, did their work admirably. The programme was rather overfilled and no lists were available to aid the participants in discovering the names of those who attended the celebrations. A reduction of 50 per cent. was allowed on the cost of tickets from the frontier to Paris, while free first-class return tickets were issued between Paris and Strasbourg to those who had been invited. During two days of the festivities in Paris motor omnibuses were to be found at seven "points de concentration" chosen with regard to the hotels at which delegates resided, thereby affording a very convenient way of transporting them to the various places where ceremonies took place, gentlemen from the Pasteur Institute and others serving as guides to the different parties. Special trains and motor transportation were, moreover, provided for the excursions to Versailles and Chantilly.

Owing to the short time that was at the disposal of the organisers, the Pasteur Museum and the Exhibition at Strasbourg were scarcely ready for inspection, the majority of the exhibits still remaining in their packing cases, this being indeed unfortunate. It is therefore inexpedient to attempt a description of the few objects that could be seen.

Those who attended the celebrations brought away mementoes of the occasion apart from the medal which they received at the Institut Pasteur. Of printed matter may be mentioned the "Souvenir des Fêtes Nationales de la Commémoration du Centenaire de la Naissance de Pasteur, célébrés à Paris, en Franche-Comté et à Strasbourg du 24 au 31 mai, 1923" (Paris: Imprimerie Nationale, 1923). This includes a chronology of Pasteur's chief discoveries (1847–1885), a facsimile of his birth certificate, three portraits of Pasteur at different ages, pictures of his birthplace, homes, and grave, striking citations from his writings, and a facsimile autograph and signature reading: "La grandeur des actions humaines se mesure à l'inspiration qui les fait naître. L. Pasteur, 27 mars 1887." The tasteful menu at the Versailles banquet and the programmes at the gala performances on May 27 bore an excellent profile portrait of Pasteur in flat relief, stamped on silvered paper, reproduced after the well-known plaque by O. Roty. The programmes distributed at Dr. Tuffier's reception and at the Hôtel de Ville bore the finely reproduced profile head of Pasteur executed by R. Lalique. At a private dinner given to some of the delegates, M. Calmette distributed to his guests some finely wrought silver medals bearing Pasteur's head modelled by G. Prudhomme and bearing the dates 1822–1922. It should be mentioned, to avoid confusion, that the national celebration was somewhat belated. In point of date, the true centenary had been previously celebrated in December 1922 at the Institut Pasteur, but these celebrations were, however, more of a domestic character.

During the festivities in Paris, the President of the Republic with a small party left for Franche-Comté, where, on May 26, he visited the house in which Pasteur was born at Dôle, attended a ceremony before Pasteur's monument there and participated at a soirée at Lons-sur-Sonier. On May 27 the presidential party visited the parental house of Pasteur at Arbois and attended ceremonies at Salins and Besançon, university functions at Besançon following on May 28 and 29, *i.e.* prior to the advent of the party in Strasbourg.

It may be mentioned incidentally that the Société de Biologie of Paris celebrated the seventy-fifth anniversary of its foundation on May 26-28, it being arranged that its meetings should clash as little as possible with those relating to the Pasteur centenary. Nevertheless, the present writer unfortunately found it impossible to attend both functions because time for rest was required between the events that constituted the very full programme.

Those who participated in the celebrations above described in a somewhat inadequate manner will have brought away, as did the writer, a delightful recollection of having revived friendships and established firmly new ties across the water.

GEORGE H. F. NUTTALL.

Cambridge Meeting of the International Union for Pure and Applied Chemistry.

THE International Union for Pure and Applied Chemistry met at Cambridge on Sunday, June 17, under the presidency of Sir W. J. Pope, and carried out the programme previously outlined in these columns (June 16, p. 825). The countries which have now joined the Union are the following—The Argentine, Australia, Belgium, Canada, Czechoslovakia, Denmark, France, Great Britain, Greece, Holland, Italy, Japan, Luxemburg, Norway, Peru, Poland, Portugal, Roumania, Spain, Switzerland, the United States of America, Uruguay, and Yougoslavia; over one hundred delegates representing the chemical interests of these countries were in attendance at Cambridge. A feature of the meeting was the presentation of several comprehensive reports on subjects which at the moment present special chemical interest; these were printed and distributed beforehand, and at the meeting brief summaries were presented by their authors, after which general discussions took place.

The report on "The Study of Soap Solutions and its Bearings upon Colloid Chemistry," presented by Prof. J. W. McBain, included a statement of the chief conclusions arrived at by its author in his extended studies of the properties of salts of the higher fatty acids. About one-half of the electrical conductivity of a soap solution is due to a negative carrier, which does not exhibit osmotic activity and is therefore colloidal; this is the ionic micelle, and consists of highly charged and solvated ionic particles. Accompanying the ionic micelle is the undissociated colloidal electrolyte, which consists of electrically neutral micelli. Interesting contributions to the discussion were made by Prof. H. E. Armstrong and Prof. W. D. Bancroft. Dr. E. K. Rideal presented a report on "Recent Developments in Contact Catalysis," in which the conception of Hardy and Langmuir, that adsorption of reactants occurs in monomolecular and orientated films, is shown capable of application to the reactions at the surface of charcoal, studied by Van Kruyt, and at the surface of the enzyme, oxidase, present in liver tissue, as studied by Hopkins.

The report contributed by Prof. J. F. Thorpe and Dr. C. K. Ingold consisted in a summary of the recent work of the authors on "Some New Aspects of Tautomerism." It is claimed that the original definition of the term "tautomerism" should be broadened, in accordance with modern investigation, and that the term should apply to all reversible isomeric change; a reasoned classification of the various types of tautomeric change which have been more carefully studied during recent years is then given. The report by Prof. F. G. Hopkins, on "Chemical Mechanisms involved in the Oxidations which occur in the Living Body," describes the success which has attended the attempts to elucidate the nature of the oxidation processes involved in living tissues by a simple chemical mechanism. In the resulting discussion, Prof. C. Moureu drew a parallel between the course of these apparently complex reactions and the catalytic oxidation of aldehydes which he has himself studied. Mr. W. Barlow showed and described a number of solid models which he has devised for the interpretation, in accordance with the valency volume law, of the results of the X-ray analysis of crystalline materials by the Laue and Bragg method; incidentally he demonstrated an hitherto unknown mode of partitioning space into identical polyhedra.

A large proportion of the time of the meeting was devoted to the work of the numerous committees which are engaged in the attempt to systematise practice throughout the world in connexion with nomenclature, abbreviations, standard methods, tables of constants, and the like.

It was decided that the Union will hold its meeting next year in Copenhagen, on the invitation of the chemical representatives of Denmark. At the concluding ceremony honorary degrees of the University of Cambridge were conferred on a number of distinguished visitors whose names were announced in the preliminary statement on the meeting (NATURE, June 16, p. 825).

Tercentenary of the Oxford Botanic Garden.

THROUGHOUT the three hundred years of its existence, the Oxford Botanic Garden can never have looked more radiant than it did on Saturday, June 23, when it welcomed the distinguished company which met to celebrate the tercentenary of its foundation. Sheltered by high and stately walls from the incessant north-east winds which in spring play havoc in more exposed gardens, it gave the impression of serene beauty, the more impressive because of the simplicity of the lines on which it has been laid out.

Those, however, who know the rigours of the Oxford climate will ascribe the luxuriance of growth of the plants in the garden rather to skill in cultivation than to good fortune with respect of site. For although the walls which surround the garden do, indeed, give shelter, the soil is none too kindly and the Thames water is too near the surface to make cultivation a light or easy task. It was, therefore, no less a tribute to their own perspicacity than to Mr. Baker, the superintendent of the gardens, that more than one speaker referred in terms of admiration to the skill in cultivation which the gardens displayed.

The Chancellor of the University, Lord Curzon, who presided at the tercentenary celebrations, spoke on gardens with the simple sincerity which proves his title to be ranked among the goodly company of true gardeners, and nothing in his speech gave more pleasure to the company which were met together under the trees of the garden than his reminiscences of the happy hours which as undergraduate and fellow he had passed in the Oxford Botanic Garden. For surely this old garden has for three centuries irradiated a happy influence on successive generations whose feet have walked therein and whose eyes have been refreshed by its scenes of peaceful beauty.

Sir David Prain, who followed the Chancellor, traced in a masterly way the history of the Garden from the time of its foundation, by the beneficence of Henry Lord Danvers, on St. James's Day (July 25), 1622. He reminded his hearers that it was in this Garden that the first greenhouses erected in England were put up, and that it was there that experiments were first made in methods of heating them. Bobert the elder and the younger, men of great wisdom; Morison, the great professor of botany and a pioneer of systematic botany; Sherard, the founder of the chair which bears his name; Sibthorpe, who deserves the title of a great botanical explorer; and Daubeny, versatile and generous,

are names which will always live, not only in the history of the Garden but also in that of botany. In more recent times, Bayley Balfour and Sydney Vines have maintained the great traditions of the Garden so that, in despite of difficult times which have occurred in the past and may recur in the future, the permanence and usefulness of the Garden are assured.

The chairman of the curators, Sir Herbert Warren, whose knowledge of the Garden extends over fifty years, in the course of a delightful speech in which he referred to the love which the Garden has inspired in the minds of Oxford men, omitted to mention the great and beneficent part which he himself has played in steering the Garden through the recent difficult years when costs have been so high and the financial resources of the University have been so strained. In helping the Garden to meet the financial difficulties inherent in these times, the University has shown wisdom and understanding that, it may be hoped, will touch the imagination of a generous benefactor and make the Garden secure for all time, not only as a place of botanical study, and as a repository of herbaria of historic and present importance, but also as a quiet sanctuary wherein men who love plants may study and admire them.

Prof. Seward, who in the absence of Lord Ullswater spoke on the subject of gardens as aids to botanical teaching and research, congratulated the University on the fact that gardens and laboratories, library and herbarium, were all assembled in one site. He referred to the generosity of Mr. Reginald Cory and other benefactors in aiding the Cambridge Botanical Garden to maintain itself, and expressed the belief that the value of the work done at Oxford and the need for assistance required only to be known to ensure the supplementing of existing resources by private benefaction.

After the formal ceremony the visitors, who numbered some 500, inspected the gardens and laboratories, admiring particularly the famous tank houses wherein the blue water-lilies (*Nymphæa zanzibarensis*, *N. gigantea*, and *N. stellata*) thrive with amazing floriferousness in company with many other Nymphæas, *Nelumbium speciosum*, the white rose-tipped Egyptian Bean of Pythagoras, *Cyperus papyrus*, graceful and historical and the source of the papyrus of antiquity, and a large assemblage of aquatic and marsh plants, all of which are of interest and collectively give a memorable impression of luxuriance which few parts of the tropics can rival.

After tea in the gardens the ceremony terminated, the departing guests averring that few among them had realised so clearly as they now did the vital part which botanic gardens play and have played in the social life of civilised communities.

University and Educational Intelligence.

EDINBURGH.—Prof. F. Gowland Hopkins, Cameron prizeman for 1922, delivered two lectures in the University on June 27 and 28 respectively, on the present position of the vitamin question. The Cameron prize, which was founded in 1878, is awarded annually to an investigator who in the course of the five years immediately preceding has made an important addition to practical therapeutics.

SHEFFIELD.—Dr. P. J. Daniell has been appointed to the Town Trust chair of mathematics.

AN Edward K. Dunham lectureship has been established at Harvard University in memory of the late Prof. E. K. Dunham, for many years professor of pathology in the Bellevue and University Medical College of New York City (*Science*, June 15). According to the terms of the gift, which is made by Prof. Dunham's widow, the lectures are to be given annually by eminent investigators and teachers in medical science or one of the contributory basic sciences, and there is no restriction as to the nationality of the lecturer. It is hoped that the foundation may "serve to bind closer the bonds of friendship and understanding between students and investigators in this and foreign countries."

AN outline of President Harding's plan for reorganising the educational activities of the Federal Government was given by the United States Commissioner of Education at the recent annual meeting of the Department of Superintendence of the National Education Association. The plan is a part of a comprehensive scheme, foreshadowed by the President in his first message to Congress and presented to the Senate in February, for a reorganisation of all the executive departments, including the establishment of a department to promote citizenship and general welfare. The educational work now carried on by some thirty separate agencies, belonging to six of the principal departments and several independent establishments, is to be included along with certain other services, the whole costing at present 700 million dollars a year, in a new Department of Education and Welfare comprising education, public health, social service, and veteran relief. The Division of Education, which will be under a permanent assistant secretary, will take over, *inter alia*, in addition to the Bureau of Education and the Board for Vocational Education, the Smithsonian Institution, including the National Museum and Art Gallery, the International Exchange Service, the Bureau of American Ethnology, the Astrophysical Observatory, the National Zoological Park, and the International Catalogue of Scientific Literature, and will create and direct an entirely new bureau for promoting physical education. The scheme is to come before Congress in December.

THE work of the University of London during the year 1922–23, measured by the usual statistical standards, shows a notable expansion. The Principal Officer, while careful to point out that the great mass of the university's continuous achievement is the expression of imponderable forces, directs attention to figures 75-200 per cent. higher than the corresponding figures for 1913–14, and points out that "we have passed well beyond the wash of what was commonly regarded as the abnormal demand for educational facilities that followed the great deliverance of 1918"; the figures are as follows: admissions (8498), candidates for degrees (3191), candidates for matriculation and registration (19,985), and other examinations (7663), and internal students (8881). There has been a noticeable decrease in the percentage of successful to total candidates from 53 in 1913–14 to 32 in 1922–23. The "growth of ignorance" among the younger generation to which Prof. John Burnet directed attention recently in the Romanes lecture is apparently not confined to Scotland. Indicative of the ever-growing specialisation of the subjects of the curricula is the increase in the number of Boards of Studies from 27 with 374 members in 1900 to 42 with 1051 members. That the senate is alive to the dangers incidental to this specialisation and resolved to guard against them is shown by its creation of a Board of Studies in "the principles, history, and method of science," designed to embrace not only the natural and mathematical sciences, but also logic, ethics, history, pedagogy, economics, linguistics, archæology, scholarship, and medicine.

Societies and Academies.

LONDON.

Royal Society, June 28.—V. H. **Blackman**, A. T. **Legg**, and F. A. **Gregory**: The effect of a direct electric current of very low intensity on the rate of growth of the coleoptile of barley. The coleoptile (sheathed plumule or young stem) of barley seedlings is exposed to an electric discharge from a point charged *positively* to about 10,000 volts (crest value) and placed at such a height above the coleoptile that a current of $0 \cdot 5 \times 10^{-10}$ amp. passes through it, the current density being 4×10^{-9} amp. per cm.^{2} Under these conditions the rate of growth is markedly accelerated from the first hour onward, showing in the third hour a percentage increase above that of the control plants of $7 \cdot 53 \pm 1 \cdot 95$. After the cessation of the current a well-marked after-effect, greater than the direct effect, is observed, the enhanced rate of growth steadily continuing and showing a percentage increase of $15 \cdot 68 \pm 2 \cdot 62$ above that of the controls. The after-effect is greater with a short period of discharge of 1 hour than with a longer period of 3 hours. When the point is *negatively* charged the rate of growth is increased during the first hour, but the increase becomes less with time. An after-effect follows, but it is markedly less. The gaseous products of the discharge and the "electric wind" play little or no part in the stimulation of growth observed. The current alone appears to be of importance.—M. S. **Pembrey**, N. W. **MacKeith**, W. R. **Spurrell**, E. C. **Warner**, and H. J. **Westlake**: Observations on the adjustment of the human body to muscular work. In the dyspnœa produced by running there is a disturbance of the acid-base equilibrium of the body; the relief of "second wind" is the result of adjustments effected chiefly by the respiration, circulation, and excretion by the kidneys and skin. The sense of discomfort during dyspnœa is associated with increased pulmonary ventilation, the sense of relief at the onset of second wind with diminished ventilation. Oliguria, or anuria, appears as a constant feature during running, even after taking 560 c.c. of tea as a diuretic. It leads to a temporary retention of acid, which helps the body to get rid of carbon dioxide and obtain oxygen; the water spared is available for excretion by the lungs and skin, and will produce by evaporation greater cooling than it would if it were discharged as urinary water. The suspension of the activity of the kidneys appears to be due to an outflow of constrictor impulses to the renal vessels.—Miss R. M. **Tupper-Carey** and J. H. **Priestley**: The composition of the cell wall at the apical meristem of stem and root. The walls of the apical meristem of stem and root differ in the ease with which cellulose may be detected in them with iodine reagents. Macro- and micro-chemical experiments show that the cellulose in the wall of the root meristem is masked by its combination with other substances, particularly proteins and fatty acids. In the shoot meristem, the cellulose is closely linked with larger quantities of pectin, but less protein and fatty acid are present, especially when the shoot is growing in the light. —L. J. **Harris**: The titration of amino- and carboxyl-groups in amino-acids, polypeptides, etc.—F. A. E. **Crew**: Studies in intersexuality. II. Sex-reversal in the fowl.—W. **Finkler**: Analytical studies on the factors causing the sexual display in the mountain newt (*Triton alpestris*).—G. A. **Schott**: On the scattering of X- and γ-rays by rings of electrons. The effect of damping of the incident radiation. Damping of the usual type, of an amount compatible with the production of moderately sharp lines in the X-ray spectrum, increases slightly the total scattering of short waves, such as the hard γ-rays, although it decreases slightly that of long waves. A single electron ring, such as is postulated in hydrogen and ionised helium on Bohr's theory, is completely unaffected by this type of damping. It seems scarcely possible that damping can diminish the total scattering for any type of atom below the amount required by the simple pulse theory.—P. A. **MacMahon**: On a class of transcendents of which the Bessel functions are a particular case.—L. C. **Martin**: The photometric matching field. Improvement in the visibility of faint contrasts observed with central vision can be obtained by stimulating the peripheral regions of the retina. An increase in precision of the order of 30 per cent. is obtained in photometric matches by surrounding the photometric field with a larger area of approximately equal brightness.—G. P. **Thomson**: Test of a theory of radiation. Experiments with positive rays show that visual and photographic effects can be obtained with trains of waves shorter than those produced in the emission of a quantum of light.—A. Ll. **Hughes** and P. **Lowe**: Intensities in the helium spectrum. The curve showing the intensity of any spectrum line as a function of the energy of impact of the electrons is characteristic of the series to which it belongs. The intensities in the doublet system all decrease rapidly as the energy of impact is increased from 34 volts. The principal series, $1S - mP$, of the singlet system is characterised by a very great increase in intensity as the energy of impact is increased from 34 volts up to about 80 volts, beyond which there is little change. The lines of the diffuse series, $1P - mD$, all show a maximum at about 75 volts. The lines of the sharp series, $1P - mS$, after a small initial rise to 60 volts, decrease slightly.—A. A. **Dee**: The effect of quenching from above the carbide transition temperature upon the magnetism of steel. The magnetism of steel at ordinary temperatures is not materially altered by quenching from above the transition temperature of iron carbide, and therefore the return of the carbide to the ferromagnetic state is not retarded by sudden cooling from above the transition temperature.—T. S. P. **Strangeways** and H. E. H. **Oakley**: The immediate changes observed in tissue cells after exposure to soft X-rays while growing *in vitro*. Exposures for gradually increasing periods, varying from 5 minutes to 2 hours, were used. There is a latent period of about 15 to 20 minutes before the changes produced in the cells by irradiation can be recognised. After 5 minutes irradiation development of new dividing cells is lessened. After exposure of 20 minutes or longer the formation of new dividing cells practically ceases. After exposure of 5 minutes granular changes and fragmentation of the chromosomes occurs in some cells in mitosis at metaphase and anaphase. After exposure of 25 minutes or longer some cells in mitosis show clumping of the chromosomes at metaphase. As the time of exposure increases there is increase in size and alteration in structure of the cytoplasm, nucleus, and nucleolus of some fully formed cells. After an exposure of 60 minutes, affected cells become disorganised, and eventually cytoplasm and nucleus break up and appear to go into solution in the surrounding medium.—W. B. **Hardy** and Ida **Doubleday**: Boundary lubrication: the latent period and mixtures of two lubricants.—C. T. R. **Wilson**: Investigations on X-rays and β-rays by the cloud method. Pt. I.—X-rays. The tracks of the electron ejected from the atom which emits the quantum of radiation and that of the electron ejected from the atom which absorbs the radiation can be identified.

Two classes of β-ray tracks are produced in air by the primary action of X-radiation of wave-length less than about 0·5 Å: (*a*) those of ejected electrons with initial kinetic energy comparable to a quantum of the incident radiation, and (*b*) tracks of very short range. The short-range electrons are ejected nearly along the direction of the primary X-rays. The short-range tracks are probably related to the phenomena which have led to the postulation of a "J"-radiation. Of the ordinary long-range tracks, the majority have a large forward component comparable with the lateral component; about 20 per cent. are ejected almost exactly at right angles to the primary X-ray beam; others have a large backward component. Partial polarisation of the primary beams is indicated by the direction of ejection of a number of the β-particles being in one plane—that containing the direction of the cathode rays in the X-ray tube. β-rays in air exposed to X-rays frequently occur in pairs or groups. The pairs probably consist of one K electron ejected by the direct action of the primary X-rays, and of a second electron ejected by the combined action of primary radiation and of the K-radiation from the atom from which the first electron was ejected. Pt. II.—β-rays. The tracks of fast β-particles are very nearly straight over distances of several centimetres. Near the end of their range the deviations are of three kinds: (*a*) sudden deviations often through large angles up to 180°, the results of a close approach to the nucleus of an atom; (*b*) sudden deviations ranging up to 45°, due to a close approach to an electron which is in consequence ejected to form a branch track generally approximately at right angles to the deflected primary track; (*c*) gradual deviations due to an accumulation of deviations of (*a*) or (*b*) type. The range of the β-ray as measured along the track is approximately proportional to the square of the kinetic energy or to the fourth power of the velocity (Whiddington's law) for ranges from about 0·1 m. to 2 cm.; the range is 1 cm. when the kinetic energy of the particle is about 21,000 volts. The primary ionisation (*i.e.* number of atoms from which electrons are ejected by the direct action of primary β-rays) is about 90 per cm. for a velocity of 10^{10} cm. per sec., and is approximately inversely as the square of the velocity. The total ionisation per cm., including that due to secondary β-particles of range too short to form visible branch tracks, is about three or four times as large as the primary. In portions of some of the tracks not only is the primary ionisation recorded, but also the ions which each of these electrons has itself produced may be counted.—C. V. **Raman** and K. R. **Ramanathan**: The molecular scattering of light in carbon-dioxide at high pressures.—W. A. **Davis** and J. V. **Eyre**: The discontinuity of the hydration process.—G. M. B. **Dobson**: A flicker type of photoelectric photometer giving high precision.—H. D. **Smyth**: The ionisation of nitrogen by electron impact.—G. M. B. **Dobson**: Measurements of the sun's ultra-violet radiation and its absorption in the earth's atmosphere.—H. **Hartridge** and F. J. W. **Roughton**: A method of measuring the velocity of very rapid chemical reactions.—W. T. **Astbury**: The crystalline structure of anhydrous racemic acid.—E. **Ponder**: The measurement of percentage hæmolysis. I.—H. M. **Fox**: Lunar periodicity in reproduction.—Marjory **Stephenson** and Margaret D. **Whetham**: Studies in the fat metabolism of the Timothy grass bacillus. II. Carbon balance sheet and respiratory quotient.—H. R. **Hewer**: Studies in amphibian colour changes. II.—R. H. **Burne**: Some peculiarities of the blood-vascular system of the Porbeagle shark (*Lamna Cornubica*).—A. E. **Boycott** and C. **Diver**: The inheritance of sinistrality in *Limnæa peregra*.

EDINBURGH.

Royal Society, May 21.—Prof. F. O. Bower, president, in the chair.—R. **Kidston** and W. H. **Lang**: (1) On *Palæopitys Milleri* (McNab). The original specimen of this stem with secondary thickening was described by Hugh Miller, and later named by McNab. A second specimen, discovered by the Geological Survey of Scotland, includes the primary central region, 1·5 mm. in diameter, surrounded by a zone of secondary xylem about 1 cm. thick. The secondary wood consists of tracheides and medullary rays. The tracheides are remarkable in having multiseriate, porose pitting on both radial and tangential walls. The primary central axis appears to have consisted of tracheides without admixture of parenchyma. There is evidence of strands of protoxylem, consisting of narrow spiral tracheides, close to the periphery of the primary xylem, just within the secondary wood. In the absence of any traces going to lateral appendages it is impossible to determine the affinities of this complex stem. It might have belonged to some gymnospermous plant, but it is equally possible that it was the stem of some archaic pteridophyte of the Middle Old Red Sandstone Period. (2) Notes on fossil plants from the Old Red Sandstone of Scotland. I. *Hicklingia Edwardi*, K. and L. Under this name a unique specimen of a Middle Old Red Sandstone plant is described and figured. It was discovered many years ago by the late Mr. G. Edward, and is preserved in the University of Manchester Museum. It occurs as an incrustation, and suggests comparison with a plant of the nature of the Rhyniaceæ spread out on a slab of Caithness flagstone. Diverging from an obscure basal region is a tuft of linear axes, without leaves, but branched dichotomously and laterally. There are indications of the presence of a slender central strand. Many of the stems terminate in oval carbonised bodies that are evidently large sporangia. The plant is compared with Rhynia and Hornea, which are known as petrifactions from the Rhynie Chert.—W. T. **Gordon**: The genus Pitys. Fossil trees belonging to this genus have been known since 1831, and it was in describing these specimens that thin sections of fossil wood were first used. A recent discovery at Gullane has disclosed twigs and stems of this type, in some cases still clothed in bark and in two specimens with leaves attached. These leaves resemble petioles in their structure, and are undoubtedly phyllodes. *Pitys dayi* affords evidence of the phyllode theory of leaf formation in gymnosperms. Pitys shows marked resemblance to Araucaria as regards the structure of the wood (recognised long ago) and the leaf-traces and leaves.

PARIS.

Academy of Sciences, June 11.—M. Albin Haller in the chair.—Edouard **Imbeaux**: The artesian basins of Australia. A map of Australia is reproduced showing the artesian basins known at the present time, taken from the report of the interstate conference on artesian water held at Adelaide in 1921.—M. Jean Perrin was elected a member of the section of general physics in succession to the late M. E. Bouty.—Paul **Montel**: Algebraic relations of class one or zero.—René **Garnier**: Uniform functions of two independent variables defined by the inversion of an algebraic system to total differentials of the fourth order.—Charles N. **Moore**: The summability of Cesàro for double Fourier's series.—Louis **Bachelier**: The general problem of discontinuous statistics.—

Stanislas **Millot**: Simplified solutions of problems of Laplace on the probability of causes.—B. **Hostinský**: The equilibrium of electricity on a cylindrical surface. —Th. De **Donder**: Synthesis of the gravific.—Adolphe **Lepape**: The radioactivity of the springs from some watering-places in the Pyrenees (Bagnères-de-Luchon, Vernet, les Escaldes, Thuès) and of the Central Plateau (la Bourboule, Royat, Saint-Nectaire, Sail-les-Bains). Determinations of the radium emanation in gases and waters from forty-four springs. Search for the thorium emanation gave mostly negative results, a few springs only showing a trace.—Albert **Nodon**: The relations between the radioactivity of radium and the activity of solar radiations. —F. **Bourion** and E. **Rouyer**: The determination of double salts in solution by the boiling-point method. A discussion of the validity of the rule of mixtures as applied to the boiling-point elevations of solutions of two electrolytes.—Jacques **Bardet**: The arc spectrum of celtium. The material used contained as impurities only zirconium and a trace of lead, and was obtained from zircons from Brazilian monazite sand. Wave-lengths of the lines in the region between 2300 and 3500 Å. are given.—Paul **Pascal**: Researches on the constitution of insoluble alkaline metaphosphates. The insoluble alkaline metaphosphates are not monometaphosphates, but furnish a remarkable example of colloids prepared at a temperature of about 850° C. The normal formula, MPO_3, should be restricted to the salts obtained starting with ethyl hexametaphosphate.—S. **Glixelli**: The influence of neutral salts on the silica gels. The acid properties of colloidal silica are increased by the addition of salts of the alkalis: the effects observed can be explained by assuming that the (OH) ions are adsorbed by the particles of silica.—A. **Mailhe**: The catalytic decomposition of the anilides. An account of the decomposition of acetanilide at 400° C. in the presence of nickel and of copper.—R. **Fosse** and A. **Hieulle**: Xanthyl derivatives of allophanic acid, thiosinamine and of allantoine.—Conrad **Kilian**: The folds of the "Tassilian enclosure" of the central Saharan massif of Ahaggar.—A. **Boit**: The rôle of the superficial folds in the structure of the formation at Morvan.—Ch. **Maurain** and Mme. de **Madinhac**: The secular variation of the intensity of the terrestrial magnetic field at Paris. Bauer has suggested the use of a local magnetic constant $G=\sqrt{H^2+(Z/2)^2}$, where H and Z are the horizontal and vertical components of the magnetic field at any point. From an examination of the records for Coimbra, Pola, Paris, Kew, Greenwich, and De Bilt, it is shown that G reached a maximum in 1902. The value of G increases with the latitude of the stations.—J. **Giral** and F. A. **Gila**: The use of sodium chloride as a standard in the estimation of the halogens in sea water. The salts present in sea water have no appreciable influence on the quantitative determination of chlorine.—J. J. **Thomasset**: Relations between the dentine and dental enamel in a fossil fish (Sargodon).—P. **Bugnon**: The homologies of cotyledonous leaves.—L. **Blaringhem**: Heredity in mosaic of the doubling of the flowers in *Cardamine pratensis*.—A. **Guillaumin**: The vacuum as a means of prolonging the germinating faculty of seeds. Seeds of radish, wheat, and lettuce, after preservation in a vacuum in the dark for 12 years, showed unimpaired powers of germination.—A. de **Puymaly**: The adaptation to aerial life of a green alga (*Chlamydomonas fungicola*).—Marc. **Bridel**: Biochemical study of the composition of *Monotropa Hypopitys*: a new glucoside, monotropeine. The new glucoside was isolated in a pure crystalline condition, 2 gm. being obtained from 5200 gm. of material. It is hydrolysed by emulsion giving a blue precipitate. Monotropeine is not identical with aucubine.—Charles **Henry**: A new test for sense of touch.—Jules **Courtier**: Experiments on a new test for the sense of touch. Results of the application of the method described in the preceding communication to nineteen subjects.—P. **Masson** and Louis **Berger**: A new mode of internal secretion.—Louis **Desliens**: The measurement of arterial pressure by the bleeding method. A very exact hæmodynamometric method and present application. The artery is punctured by a hollow needle communicating with a delicate pressure-gauge of the aneroid type. The instrument before use is filled with a saline solution to prevent coagulation.—J. **Lopez-Lomba**: Changes of weight of the organs of the guinea-pig during C-avitaminosis.—F. **Franchette**: The pneumo-anæsthesiograph. An account of an instrument designed to evaluate and record the amplitude and frequency of the respiratory movements during anæsthesia.—Emile F. **Terroine** and H. **Barthélemy**: The composition of the eggs in the course of ovogenesis in the brown frog (*Rana fusca*).—M. **Caille** and E. **Viel**: The detection of small quantities of antimony and bismuth in biological liquids. An application of the antipyrine-potassium iodide reagent described in an earlier communication.—M. **Lemoigne**: The production of β-oxybutyric acid by certain bacteria of the *B. subtilis* group.—Charles **Pérez**: The casting of the shell of decapod crustaceans carrying parasites (Epicaridæ).—Boris **Ephrussi**: The sexuality of *Clava squamata*.—C. **Levaditi** and T. **Nicolau**: Tissue immunity in neurotrope ectodermosis.—Emile **Gautrelet**: Monomethylorthophospho-salicylic acid.

Official Publications Received.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia, Jaarverslag 1922. Pp. 26. (Weltevreden, Java: Landsdrukkerij.)

Survey of India. General Report 1921-22, from 1st October 1921 to 30th September 1922. Prepared under the Direction of Col. C. H. D. Ryder. Pp. vi+49+8 maps. (Calcutta: Survey of India.) 2·4 rupees; 4s.

Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1922. Pp. 10. (Salisbury, Rhodesia.)

Nauka Polska: jej Potrzeby, Organizacja i Rozwój. (La Science Polonaise: ses Besoins, son Organisation et ses Progrès.) Tom 4. Pp. ix+590. (Warszawa: Im. Mianowskiego.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106: Ergebnisse Aerologischer Beobachtungen, 10, 1921. Pp. xiii+83. No. 108: Seismische Registrierungen in De Bilt, 7, 1919. Pp. xi+68. No. 110: Oceanographische en Meteorologische Waarnemingen in den Atlantischen Oceaan, Maart, April, Mei (1856-1920.) Tabellen. Pp. iii+186. 15 Fl. Planches. Pp. 24. 7.50 Fl. (Utrecht: Kemink en Zoon.)

Diary of Societies.

TUESDAY, JULY 10.

SOCIOLOGICAL SOCIETY (at Leplay House, 65 Belgrave Road), at 5.45.—C. Dawson: Progress and Decay in Ancient and Modern Civilisations (Lecture).

THURSDAY, JULY 12.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

TUESDAY, JULY 17.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

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The Structure of the Atom.[1]

By Prof. N. Bohr.

The General Picture of the Atom.

THE present state of atomic theory is characterised by the fact that we not only believe the existence of atoms to be proved beyond a doubt, but also we even believe that we have an intimate knowledge of the constituents of the individual atoms. I cannot on this occasion give a survey of the scientific developments that have led to this result; I will only recall the discovery of the electron towards the close of the last century, which furnished the direct verification and led to a conclusive formulation of the conception of the atomic nature of electricity which had evolved since the discovery by Faraday of the fundamental laws of electrolysis and Berzelius's electrochemical theory, and had its greatest triumph in the electrolytic dissociation theory of Arrhenius. This discovery of the electron and elucidation of its properties was the result of the work of a large number of investigators, among whom Lenard and J. J. Thomson may be particularly mentioned. The latter especially has made very important contributions to our subject by his ingenious attempts to develop ideas about atomic constitution on the basis of the electron theory. The present state of our knowledge of the elements of atomic structure was reached, however, by the discovery of the atomic nucleus, which we owe to Rutherford, whose work on the radioactive substances discovered towards the close of the last century has much enriched physical and chemical science.

According to our present conceptions, an atom of an element is built up of a nucleus that has a positive electrical charge and is the seat of by far the greatest part of the atomic mass, together with a number of electrons, all having the same negative charge and mass, which move at distances from the nucleus that are very great compared to the dimensions of the nucleus or of the electrons themselves. In this picture we at once see a striking resemblance to a planetary system, such as we have in our own solar system. Just as the simplicity of the laws that govern the motions of the solar system is intimately connected with the circumstance that the dimensions of the moving bodies are small in relation to the orbits, so the corresponding relations in atomic structure provide us with an explanation of an essential feature of natural phenomena in so far as these depend on the properties of the elements. It makes clear at once that these properties can be divided into two sharply distinguished classes.

To the first class belong most of the ordinary physical and chemical properties of substances, such as their state of aggregation, colour, and chemical reactivity. These properties depend on the motion of the electron system and the way in which this motion changes under the influence of different external actions. On account of the large mass of the nucleus relative to that of the electrons and its smallness in comparison to the electron orbits, the electronic motion will depend only to a very small extent on the nuclear mass, and will be determined to a close approximation solely by the total electrical charge of the nucleus. Especially the inner structure of the nucleus and the way in which the charges and masses are distributed among its separate particles will have a vanishingly small influence on the motion of the electron system surrounding the nucleus. On the other hand, the structure of the nucleus will be responsible for the second class of properties that are shown in the radioactivity of substances. In the radioactive processes we meet with an explosion of the nucleus, whereby positive or negative particles, the so-called α- and β-particles, are expelled with very great velocities.

Our conceptions of atomic structure afford us, therefore, an immediate explanation of the complete lack of interdependence between the two classes of properties, which is most strikingly shown in the existence of substances which have to an extraordinarily close approximation the same ordinary physical and chemical properties, even though the atomic weights are not the same, and the radioactive properties are completely different. Such substances, of the existence of which the first evidence was found in the work of Soddy and other investigators on the chemical properties of the radioactive elements, are called isotopes, with reference to the classification of the elements according to ordinary physical and chemical properties. It is

[1] Lecture delivered at Stockholm, December 11, 1922, on the occasion of the receipt of the Nobel prize in physics for the year 1922. English translation by Dr. Frank C. Hoyt.

not necessary for me to state here how it has been shown in recent years that isotopes are found not only among the radioactive elements, but also among ordinary stable elements; in fact, a large number of the latter that were previously supposed simple have been shown by Aston's well-known investigations to consist of a mixture of isotopes with different atomic weights.

The question of the inner structure of the nucleus is still but little understood, although a method of attack is afforded by Rutherford's experiments on the disintegration of atomic nuclei by bombardment with α-particles. Indeed, these experiments may be said to open up a new epoch in natural philosophy in that for the first time the artificial transformation of one element into another has been accomplished. In what follows, however, we shall confine ourselves to a consideration of the ordinary physical and chemical properties of the elements and the attempts which have been made to explain them on the basis of the concepts just outlined.

It is well known that the elements can be arranged as regards their ordinary physical and chemical properties in a *natural system* which displays most suggestively the peculiar relationships between the different elements. It was recognised for the first time by Mendeléeff and Lothar Meyer that when the elements are arranged in an order which is practically that of their atomic weights, their chemical and physical properties show a pronounced periodicity. A diagrammatic representation of this so-called periodic table is given in Fig. 1, where, however, the elements are not arranged in the ordinary way but in a somewhat modified form of a table first given by Julius Thomsen, who has also made important contributions to science in this domain. In the figure the elements are denoted by their usual chemical symbols, and the different vertical columns indicate the so-called periods. The elements in successive columns which possess homologous chemical and physical properties are connected with lines. The meaning of the square brackets around certain series of elements in the later periods, the properties of which exhibit typical deviations from the simple periodicity in the first periods, will be discussed later.

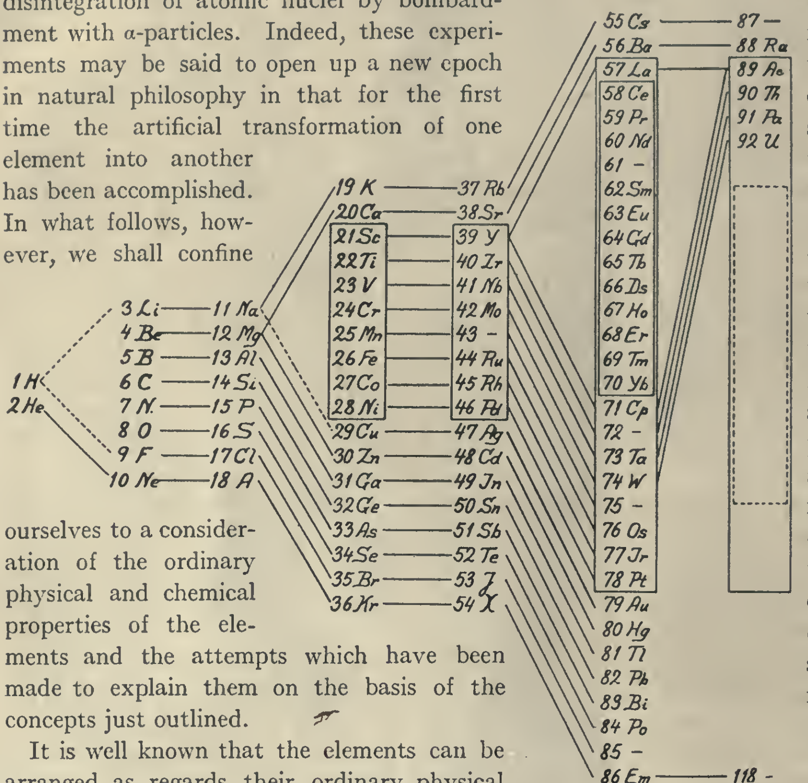

Fig. 1.

In the development of the theory of atomic structure the characteristic features of the natural system have found a surprisingly simple interpretation. Thus we are led to assume that the ordinal number of an element in the periodic table, the so-called atomic number, is just equal to the number of electrons which move about the nucleus in the neutral atom. In an imperfect form, this law was first stated by Van den Broek; it was, however, foreshadowed by J. J. Thomson's investigations of the number of electrons in the atom, as well as by Rutherford's measurements of the charge on the atomic nucleus. As we shall see, convincing support for this law has since been obtained in various ways, especially by Moseley's famous investigations of the X-ray spectra of the elements. We may perhaps also point out, how the simple connexion between atomic number and nuclear charge offers an explanation of the laws governing the changes in chemical properties of the elements after expulsion of α- or β-particles, which found a simple formulation in the so-called radioactive displacement law.

Atomic Stability and Electrodynamic Theory.

As soon as we try to trace a more intimate connexion between the properties of the elements and atomic structure, we encounter profound difficulties, in that essential differences between an atom and a planetary system show themselves here in spite of the analogy we have mentioned.

The motions of the bodies in a planetary system, even though they obey the general law of gravitation, will not be completely determined by this law alone, but will depend largely on the previous history of the system. Thus the length of the year is not determined by the masses of the sun and the earth alone, but depends also on the conditions that existed during the formation of the solar system, of which we have very little knowledge. Should a sufficiently large foreign body some day traverse our solar system, we might among other effects expect that from that

day the length of the year would be different from its present value.

It is quite otherwise in the case of atoms. The definite and unchangeable properties of the elements demand that the state of an atom cannot undergo permanent changes due to external actions. As soon as the atom is left to itself again, its constituent particles must arrange their motions in a manner which is completely determined by the electric charges and masses of the particles. We have the most convincing evidence of this in spectra, that is, in the properties of the radiation emitted from substances in certain circumstances, which can be studied with such great precision. It is well known that the wave-lengths of the spectral lines of a substance, which can in many cases be measured with an accuracy of more than one part in a million, are, in the same external circumstances, always exactly the same within the limit of error of the measurements, and quite independent of the previous treatment of this substance. It is just to this circumstance that we owe the great importance of spectral analysis, which has been such an invaluable aid to the chemist in the search for new elements, and has also shown us that even on the most distant bodies of the universe there occur elements with exactly the same properties as on the earth.

On the basis of our picture of the constitution of the atom it is thus impossible, so long as we restrict ourselves to the ordinary mechanical laws, to account for the characteristic atomic stability which is required for an explanation of the properties of the elements.

The situation is by no means improved if we also take into consideration the well-known electrodynamic laws which Maxwell succeeded in formulating on the basis of the great discoveries of Oersted and Faraday in the first half of the last century. Maxwell's theory has not only shown itself able to account for the already known electric and magnetic phenomena in all their details, but has also celebrated its greatest triumph in the prediction of the electromagnetic waves which were discovered by Hertz, and are now so extensively used in wireless telegraphy.

For a time it seemed as though this theory would also be able to furnish a basis for an explanation of the details of the properties of the elements, after it had been developed, chiefly by Lorentz and Larmor, into a form consistent with the atomistic conception of electricity. I need only remind you of the great interest that was aroused when Lorentz, shortly after the discovery by Zeeman of the characteristic changes that spectral lines undergo when the emitting substance is brought into a magnetic field, could give a natural and simple explanation of the main features of the phenomenon. Lorentz assumed that the radiation which we observe in a spectral line is sent out from an electron executing simple harmonic vibrations about a position of equilibrium in precisely the same manner as the electromagnetic waves in radio-telegraphy are sent out by the electric oscillations in the antennæ. He also pointed out how the alteration observed by Zeeman in the spectral lines corresponded exactly to the alteration in the motion of the vibrating electron which one would expect to be produced by the magnetic field.

It was, however, impossible on this basis to give a closer explanation of the spectra of the elements, or even of the general type of the laws holding with great exactness for the wave-lengths of lines in these spectra, which had been established by Balmer, Rydberg, and Ritz. After we obtained details as to the constitution of the atom, this difficulty became still more manifest; in fact, so long as we confine ourselves to the classical electrodynamic theory we cannot even understand why we obtain spectra consisting of sharp lines at all. This theory can even be said to be incompatible with the assumption of the existence of atoms possessing the structure we have described, in that the motions of the electrons would claim a continuous radiation of energy from the atom, which would cease only when the electrons had fallen into the nucleus.

The Origin of the Quantum Theory.

It has, however, been possible to avoid the various difficulties of the electrodynamic theory by introducing concepts borrowed from the so-called quantum theory, which marks a complete departure from the ideas that have hitherto been used for the explanation of natural phenomena. This theory was originated by Planck, in the year 1900, in his investigations on the law of heat radiation, which, because of its independence of the individual properties of substances, lent itself peculiarly well to a test of the applicability of the laws of classical physics to atomic processes.

Planck considered the equilibrium of radiation between a number of systems with the same properties as those on which Lorentz had based his theory of the Zeeman effect, but he could now show not only that classical physics could not account for the phenomena of heat radiation, but also that a complete agreement with the experimental law could be obtained if—in pronounced contradiction to classical theory—it were assumed that the energy of the vibrating electrons could not change continuously, but only in such a way that the energy of the system always remained equal to a whole number of so-called energy-quanta. The magnitude of this quantum was found

to be proportional to the frequency of oscillation of the particle, which, in accordance with classical concepts, was supposed to be also the frequency of the emitted radiation. The proportionality factor had to be regarded as a new universal constant, since termed Planck's constant, similar to the velocity of light and the charge and mass of the electron.

Planck's surprising result stood at first completely isolated in natural science, but with Einstein's significant contributions to this subject a few years after, a great variety of applications was found. In the first place, Einstein pointed out that the condition limiting the amount of vibrational energy of the particles could be tested by investigation of the specific heat of crystalline bodies, since in the case of these we have to do with similar vibrations, not of a single electron, but of whole atoms about positions of equilibrium in the crystal lattice. Einstein was able to show that the experiment confirmed Planck's theory, and through the work of later investigators this agreement has proved quite complete. Furthermore, Einstein emphasised another consequence of Planck's results, namely, that radiant energy could only be emitted or absorbed by the oscillating particle in so-called "quanta of radiation," the magnitude of each of which was equal to Planck's constant multiplied by the frequency.

In his attempts to give an interpretation of this result, Einstein was led to the formulation of the so-called "hypothesis of light-quanta," according to which the radiant energy, in contradiction to Maxwell's electromagnetic theory of light, would not be propagated as electromagnetic waves, but rather as concrete light atoms, each with an energy equal to that of a quantum of radiation. This concept led Einstein to his well-known theory of the photo-electric effect. This phenomenon, which had been entirely unexplainable on the classical theory, was thereby placed in a quite different light, and the predictions of Einstein's theory have received such exact experimental confirmation in recent years, that perhaps the most exact determination of Planck's constant is afforded by measurements on the photo-electric effect. In spite of its heuristic value, however, the hypothesis of light-quanta, which is quite irreconcilable with so-called interference phenomena, is not able to throw light on the nature of radiation. I need only recall that these interference phenomena constitute our only means of investigating the properties of radiation and therefore of assigning any closer meaning to the frequency which in Einstein's theory fixes the magnitude of the light-quantum.

In the following years many efforts were made to apply the concepts of the quantum theory to the question of atomic structure, and the principal emphasis was sometimes placed on one and sometimes on the other of the consequences deduced by Einstein from Planck's result. As the best known of the attempts in this direction, from which, however, no definite results were obtained, I may mention the work of Stark, Sommerfeld, Hasenöhrl, Haas, and Nicholson.

From this period also dates an investigation by Bjerrum on infra-red absorption bands, which, although it had no direct bearing on atomic structure, proved significant for the development of the quantum theory. He directed attention to the fact that the rotation of the molecules in a gas might be investigated by means of the changes in certain absorption lines with temperature. At the same time he emphasised the fact that the effect should not consist of a continuous widening of the lines such as might be expected from classical theory, which imposed no restrictions on the molecular rotations, but in accordance with the quantum theory he predicted that the lines should be split up into a number of components, corresponding to a sequence of distinct possibilities of rotation. This prediction was confirmed a few years later by Eva von Bahr, and the phenomenon may still be regarded as one of the most striking evidences of the reality of the quantum theory, even though from our present point of view the original explanation has undergone a modification in essential details.

The Quantum Theory of Atomic Constitution.

The question of further development of the quantum theory was in the meantime placed in a new light by Rutherford's discovery of the atomic nucleus (1911). As we have already seen, this discovery made it quite clear that by classical conceptions alone it was quite impossible to understand the most essential properties of atoms. One was therefore led to seek for a formulation of the principles of the quantum theory that could immediately account for the stability in atomic structure and the properties of the radiation sent out from atoms, of which the observed properties of substances bear witness. Such a formulation was proposed (1913) by the present lecturer in the form of two postulates, which may be stated as follows:

1. Among the conceivably possible states of motion in an atomic system there exist a number of so-called *stationary states* which, in spite of the fact that the motion of the particles in these states obeys the laws of classical mechanics to a considerable extent, possess a peculiar, mechanically unexplainable stability, of such a sort that every permanent change in the motion of the system must consist in a complete transition from one stationary state to another.

2. While in contradiction to the classical electromagnetic theory no radiation takes place from the atom in the stationary states themselves, a process of transition between two stationary states can be accompanied by the emission of electromagnetic radiation, which will have the same properties as that which would be sent out according to the classical theory from an electrified particle executing an harmonic vibration with constant frequency. This frequency ν has, however, no simple relation to the motion of the particles of the atom, but is given by the relation

$$h\nu = E' - E'',$$

where h is Planck's constant, and E' and E'' are the values of the energy of the atom in the two stationary states that form the initial and final state of the radiation process. Conversely, irradiation of the atom with electromagnetic waves of this frequency can lead to an absorption process, whereby the atom is transformed back from the latter stationary state to the former.

While the first postulate has in view the general stability of the atom, the second postulate has chiefly in view the existence of spectra with sharp lines. Furthermore, the quantum theory condition entering in the last postulate affords a starting point for the interpretation of the laws of series spectra. The most general of these laws, the combination principle enunciated by Ritz, states that the frequency ν for each of the lines in the spectrum of an element can be represented by the formula

$$\nu = T'' - T',$$

where T'' and T' are two so-called "spectral terms" belonging to a manifold of such terms characteristic of the substance in question.

According to our postulates, this law finds an immediate interpretation in the assumption that the spectrum is emitted by transitions between a number of stationary states in which the numerical value of the energy of the atom is equal to the value of the spectral term multiplied by Planck's constant. This explanation of the combination principle is seen to differ fundamentally from the usual ideas of electrodynamics, as soon as we consider that there is no simple relation between the motion of the atom and the radiation sent out. The departure of our considerations from the ordinary ideas of natural philosophy becomes particularly evident, however, when we observe that the occurrence of two spectral lines, corresponding to combinations of the same spectral term with two other different terms, implies that the nature of the radiation sent out from the atom is not determined only by the motion of the atom at the beginning of the radiation process, but also depends on the state to which the atom is transferred by the process.

At first glance one might, therefore, think that it would scarcely be possible to bring our formal explanation of the combination principle into direct relation with our views regarding the constitution of the atom, which, indeed, are based on experimental evidence interpreted on classical mechanics and electrodynamics. A closer investigation, however, should make it clear that a definite relation may be obtained between the spectra of the elements and the structure of their atoms on the basis of the postulates.

The Hydrogen Spectrum.

The simplest spectrum we know is that of hydrogen. The frequencies of its lines may be represented with great accuracy by means of Balmer's formula:

$$\nu = K\left(\frac{1}{n''^2} - \frac{1}{n'^2}\right),$$

where K is a constant and n' and n'' are two integers. In the spectrum we accordingly meet a single series of spectral terms of the form K/n^2, which decrease regularly with increasing term number n. In accordance with the postulates, we shall therefore assume that each of the hydrogen lines is emitted by a transition between two states belonging to a series of stationary states of the hydrogen atom in which the numerical value of the atom's energy is equal to hK/n^2.

Following our picture of atomic structure, a hydrogen atom consists of a positive nucleus and an electron which—so far as ordinary mechanical conceptions are applicable—will with great approximation describe a periodic elliptical orbit with the nucleus at one focus. The major axis of the orbit is inversely proportional to the work necessary completely to remove the electron from the nucleus, and, in accordance with the above, this work in the stationary states is just equal to hK/n^2. We thus arrive at a manifold of stationary states for which the major axis of the electron orbit takes on a series of discrete values proportional to the squares of the whole numbers. The accompanying Fig. 2 shows these relations diagrammatically. For the sake of simplicity the electron orbits in the stationary states are represented by circles, although in reality the theory places no restriction on the eccentricity of the orbit, but only determines the length of the major axis. The arrows represent the transition processes that correspond to the red and green hydrogen lines, Hα and Hβ, the frequency of which is given by means of the Balmer formula when we put $n'' = 2$ and $n' = 3$ and 4 respectively. The transition processes are also represented which correspond to the first three lines of the series

of ultra-violet lines found by Lyman in 1914, of which the frequencies are given by the formula when n is put equal to 1, as well as to the first line of the infra-red series discovered some years previously by Paschen, which are given by the formula if n'' is put equal to 3.

This explanation of the origin of the hydrogen spectrum leads us quite naturally to interpret this spectrum as the manifestation of a process whereby the electron is bound to the nucleus. While the largest spectral term with term number 1 corresponds to the final stage in the binding process, the small spectral terms that have larger values of the term number correspond to stationary states which represent the initial states of the binding process, where the

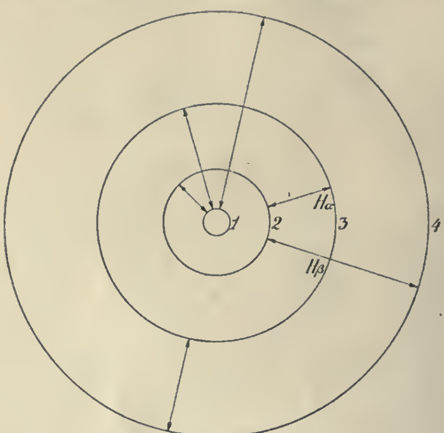

Fig. 2.

electron orbits still have large dimensions, and where the work required to remove an electron from the nucleus is still small. The final stage in the binding process we may designate as the normal state of the atom, and it is distinguished from the other stationary states by the property that, in accordance with the postulates, the state of the atom can only be changed by the addition of energy whereby the electron is transferred to an orbit of larger dimensions corresponding to an earlier stage of the binding process.

The size of the electron orbit in the normal state calculated on the basis of the above interpretation of the spectrum agrees roughly with the value for the dimensions of the atoms of the elements that have been calculated by the kinetic theory of matter from the properties of gases. Since, however, as an immediate consequence of the stability of the stationary states that is claimed by the postulates, we must suppose that the interaction between two atoms during a collision cannot be completely described with the aid of the laws of classical mechanics, such a comparison as this cannot be carried further on the basis of such considerations as those just outlined.

A more intimate connexion between the spectra and the atomic model has been revealed, however, by an investigation of the motion in those stationary states where the term number is large, and where the dimensions of the electron orbit and the frequency of revolution in it vary relatively little when we go from one stationary state to the next following. It was possible to show that the frequency of the radiation sent out during the transition between two stationary states, the difference of the term numbers of which is small in comparison to these numbers themselves, tended to coincide in frequency with one of the harmonic components into which the electron motion could be resolved, and accordingly also with the frequency of one of the wave trains in the radiation which would be emitted according to the laws of ordinary electrodynamics.

The condition that such a coincidence should occur in this region where the stationary states differ but little from one another proves to be that the constant in the Balmer formula can be expressed by means of the relation

$$K = \frac{2\pi^2 e^4 m}{h^3},$$

where e and m are respectively the charge and mass of the electron, while h is Planck's constant. This relation has been shown to hold to within the considerable accuracy with which, especially through the beautiful investigations of Millikan, the quantities e, m, and h are known.

This result shows that there exists a connexion between the hydrogen spectrum and the model for the hydrogen atom which, on the whole, is as close as we might hope considering the departure of the postulates from the classical mechanical and electrodynamic laws. At the same time, it affords some indication of how we may perceive in the quantum theory, in spite of the fundamental character of this departure, a natural generalisation of the fundamental concepts of the classical electrodynamic theory. To this most important question we shall return later, but first we will discuss how the interpretation of the hydrogen spectrum on the basis of the postulates has proved suitable in several ways, for elucidating the relation between the properties of the different elements.

Relationships between the Elements.

The discussion above can be applied immediately to the process whereby an electron is bound to a nucleus with any given charge. The calculations show that, in the stationary state corresponding to a given value of the number n, the size of the orbit will be inversely proportional to the nuclear charge, while the work necessary to remove an electron will be directly proportional to the square of the nuclear charge. The spectrum that is emitted during the binding of an electron by a nucleus with charge N

times that of the hydrogen nucleus can therefore be represented by the formula:

$$\nu = N^2 K\left(\frac{1}{n''^2} - \frac{1}{n'^2}\right).$$

If in this formula we put $N=2$, we get a spectrum which contains a set of lines in the visible region which was observed many years ago in the spectrum of certain stars. Rydberg assigned these lines to hydrogen because of the close analogy with the series of lines represented by the Balmer formula. It was never possible to produce these lines in pure hydrogen, but just before the theory for the hydrogen spectrum was put forward, Fowler succeeded in observing the series in question by sending a strong discharge through a mixture of hydrogen and helium. This investigator also assumed that the lines were hydrogen lines, because there existed no experimental evidence from which it might be inferred that two different substances could show properties resembling each other so much as the spectrum in question and that of hydrogen. After the theory was put forward, it became clear, however, that the observed lines must belong to a spectrum of helium, but that they were not like the ordinary helium spectrum emitted from the neutral atom. They came from an ionised helium atom which consists of a single electron moving about a nucleus with double charge. In this way there was brought to light a new feature of the relationship between the elements, which corresponds exactly with our present ideas of atomic structure, according to which the physical and chemical properties of an element depend in the first instance only on the electric charge of the atomic nucleus.

Soon after this question was settled the existence of a similar general relationship between the properties of the elements was brought to light by Moseley's well-known investigations on the characteristic X-ray spectra of the elements, which was made possible by Laue's discovery of the interference of X-rays in crystals and the investigations of W. H. and W. L. Bragg on this subject. It appeared, in fact, that the X-ray spectra of the different elements possessed a much simpler structure and a much greater mutual resemblance than their optical spectra. In particular, it appeared that the spectra changed from element to element in a manner that corresponded closely to the formula given above for the spectrum emitted during the binding of an electron to a nucleus, provided N was put equal to the atomic number of the element concerned. This formula was even capable of expressing, with an approximation that could not be without significance, the frequencies of the strongest X-ray lines, if small whole numbers were substituted for n' and n''.

This discovery was of great importance in several respects. In the first place, the relationship between the X-ray spectra of different elements proved so simple that it became possible to fix without ambiguity the atomic number for all known substances, and in this way to predict with certainty the atomic number of all such hitherto unknown elements for which there is a place in the natural system. Fig. 3 shows how the square root of the frequency for two characteristic X-ray lines depends on the atomic number. These lines belong to the group of so-called K-lines, which are the most penetrating of the characteristic rays. With very close approximation the points lie on straight lines, and the fact that they do so is conditioned not only by our taking account of known elements, but also by our leaving an open place between molybdenum (42) and ruthenium (44), just as in Mendeléeff's original scheme of the natural system of the elements.

Fig. 3.

Further, the laws of X-ray spectra provide a confirmation of the general theoretical conceptions, both with regard to the constitution of the atom and the ideas that have served as a basis for the interpretation

of spectra. Thus the similarity between X-ray spectra and the spectra emitted during the binding of a single electron to a nucleus may be simply interpreted from the fact that the transitions between stationary states with which we are concerned in X-ray spectra are accompanied by changes in the motion of an electron in the inner part of the atom, where the influence of the attraction of the nucleus is very great compared with the repulsive forces of the other electrons.

The relations between other properties of the elements are of a much more complicated character, which originates in the fact that we have to do with processes concerning the motion of the electrons in the outer part of the atom, where the forces that the electrons exert on one another are of the same order of magnitude as the attraction towards the nucleus, and where, therefore, the details of the interaction of the electrons play an important part. A characteristic example of such a case is afforded by the spatial extension of the atoms of the elements. Lothar Meyer himself directed attention to the characteristic periodic change exhibited by the ratio of the atomic weight to the density, the so-called atomic volume, of the elements in the natural system. An idea of these facts is given by Fig. 4, in which the atomic volume is represented as a function of the atomic number. A greater difference between this and the previous figure could scarcely be imagined. While the X-ray spectra vary uniformly with the atomic number, the atomic volumes show a characteristic periodic change which corresponds exactly to the change in the chemical properties of the elements.

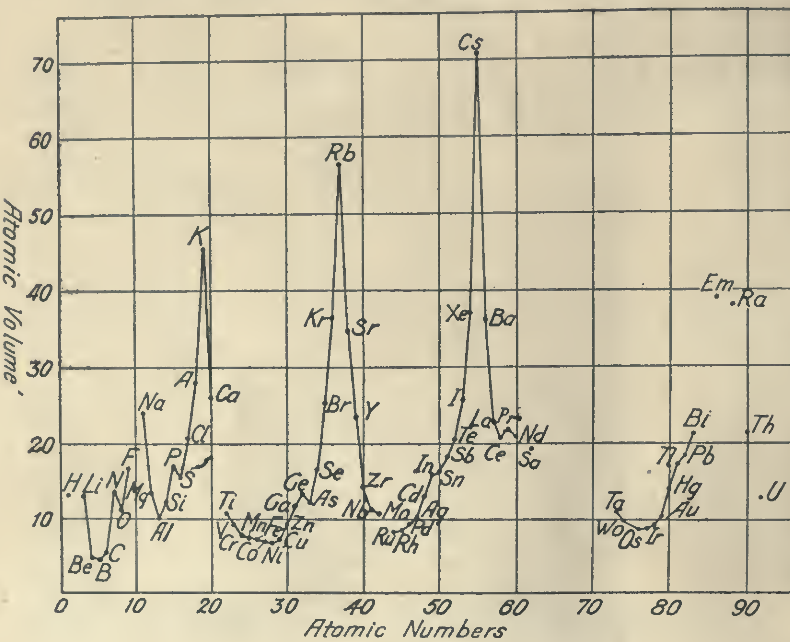

Fig. 4.

Ordinary optical spectra behave in an analogous way. In spite of the dissimilarity between these spectra, Rydberg succeeded in tracing a certain general relationship between the hydrogen spectrum and other spectra. Even though the spectral lines of the elements with higher atomic number appear as combinations of a more complicated manifold of spectral terms which is not so simply co-ordinated with a series of whole numbers, still the spectral terms can be arranged in series each of which shows a strong similarity to the series of terms in the hydrogen spectrum. This similarity appears in the fact that the terms in each series can, as Rydberg pointed out, be very accurately represented by the formula $K/(n+\alpha)^2$, where K is the same constant that occurs in the hydrogen spectrum, often called the Rydberg constant, while n is the term number, and α a constant which is different for the different series.

This relationship with the hydrogen spectrum leads us immediately to regard these spectra as the *last step of a process whereby the neutral atom is built up by the capture and binding of electrons to the nucleus*, one by one. In fact, it is clear that the last electron captured, so long as it is in that stage of the binding process in which its orbit is still large compared to the orbits of the previously bound electrons, will be subjected to a force from the nucleus and these electrons, that differs but little from the force with which the electron in the hydrogen atom is attracted towards the nucleus while it is moving in an orbit of corresponding dimensions.

The spectra so far considered, for which Rydberg's laws hold, are excited by means of electric discharge under ordinary conditions and are often called arc spectra. The elements emit also another type of spectrum, the so-called spark spectra, when they are subjected to an extremely powerful discharge. Hitherto it was impossible to disentangle the spark spectra in the same way as the arc spectra. Shortly after the above view on the origin of arc spectra was brought forward, however, Fowler found (1914) that an empirical expression for the spark spectrum lines could be established which corresponds exactly to Rydberg's laws with the single difference that the constant K is replaced by a constant four times as large. Since, as we have seen, the constant that appears in the spectrum sent out during the binding

of an electron to a helium nucleus is exactly equal to 4 K, it becomes evident that spark spectra are due to the ionised atom, and that their emission corresponds to *the last step but one in the formation of the neutral atom* by the successive capture and binding of electrons.

Absorption and Excitation of Spectral Lines.

The interpretation of the origin of the spectra was also able to explain the characteristic laws that govern absorption spectra. As Kirchhoff and Bunsen had already shown, there is a close relation between the selective absorption of substances for radiation and their emission spectra, and it is on this that the application of spectrum analysis to the heavenly bodies essentially rests. Yet on the basis of the classical electromagnetic theory, it is impossible to understand why substances in the form of vapour show absorption for certain lines in their emission spectrum and not for others.

On the basis of the postulates given above we are, however, led to assume that the absorption of radiation corresponding to a spectral line emitted by a transition from one stationary state of the atom to a state of less energy is brought about by the return of the atom from the last-named state to the first. We thus understand immediately that in ordinary circumstances a gas or vapour can only show selective absorption for spectral lines that are produced by a transition from a state corresponding to an earlier stage in the binding process to the normal state. Only at higher temperatures or under the influence of electric discharges whereby an appreciable number of atoms are being constantly disrupted from the normal state, can we expect absorption for other lines in the emission spectrum in agreement with the experiments.

A most direct confirmation for the general interpretation of spectra on the basis of the postulates has also been obtained by investigations on the excitation of spectral lines and ionisation of atoms by means of impact of free electrons with given velocities. A decided advance in this direction was marked by the well-known investigations of Franck and Hertz (1914). It appeared from their results that by means of electron impacts it was impossible to impart to an atom an arbitrary amount of energy, but only such amounts as corresponded to a transfer of the atom from its normal state to another stationary state of the existence of which the spectra assure us, and the energy of which can be inferred from the magnitude of the spectral term.

Further, striking evidence was afforded of the independence that, according to the postulates, must be attributed to the processes which give rise to the emission of the different spectral lines of an element. Thus it could be shown directly that atoms that were transferred in this manner to a stationary state of greater energy were able to return to the normal state with emission of radiation corresponding to a single spectral line.

Continued investigations on electron impacts, in which a large number of physicists have shared, have also produced a detailed confirmation of the theory concerning the excitation of series spectra. Especially it has been possible to show that for the *ionisation* of an atom by electron impact an amount of energy is necessary that is exactly equal to the work required, according to the theory, to remove the last electron captured from the atom. This work can be determined directly as the product of Planck's constant and the spectral term corresponding to the normal state, which, as mentioned above, is equal to the limiting value of the frequencies of the spectral series connected with selective absorption.

The Quantum Theory of Multiply-Periodic Systems.

While it was thus possible by means of the fundamental postulates of the quantum theory to account directly for certain general features of the properties of the elements, a closer development of the ideas of the quantum theory was necessary in order to account for these properties in further detail. In the course of the last few years a more general theoretical basis has been attained through the development of formal methods that permit the fixation of the stationary states for electron motions of a more general type than those we have hitherto considered. For a simply periodic motion such as we meet in the pure harmonic oscillator, and at least to a first approximation, in the motion of an electron about a positive nucleus, the manifold of stationary states can be simply co-ordinated to a series of whole numbers. For motions of the more general class mentioned above, the so-called *multiply-periodic* motions, however, the stationary states compose a more complex manifold, in which, according to these formal methods, each state is characterised by several whole numbers, the so-called "quantum numbers."

In the development of the theory a large number of physicists have taken part, and the introduction of several quantum numbers can be traced back to the work of Planck himself. But the definite step which gave the impetus to further work was made by Sommerfeld (1915) in his explanation of the fine structure shown by the hydrogen lines when the spectrum is observed with a spectroscope of high resolving power. The occurrence of this fine structure must be ascribed to the circumstance that we have to deal, even in hydrogen, with a motion which is not exactly simply periodic. In fact, as a consequence of the change in the electron's mass with velocity that is claimed by the theory of relativity, the electron orbit will undergo a very slow precession in the orbital plane. The motion will therefore be doubly periodic, and besides a number characterising the term in the Balmer formula, which we shall call the *principal quantum number* because it determines in the main the energy of the atom, the fixation of the stationary

states demands another quantum number which we shall call the *subordinate quantum number*.

A survey of the motion in the stationary states thus fixed is given in the diagram (Fig. 5), which reproduces the relative size and form of the electron orbits. Each orbit is designated by a symbol n_k, where n is the principal quantum number and k the subordinate quantum number. All orbits with the same principal quantum number have, to a first approximation, the same major axis, while orbits with the same value of k have the same parameter, *i.e.* the same value for the shortest chord through the focus. Since the energy values for different states with the same value of n but different values of k differ a little from each other, we get for each hydrogen line corresponding to definite values of n' and n'' in the Balmer formula a number of different transition processes, for which the frequencies of the emitted radiation as calculated by the second postulate are

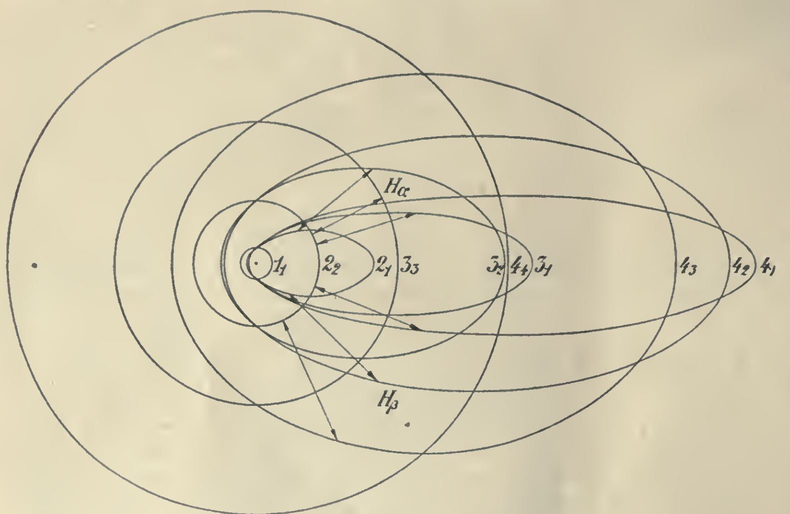

FIG. 5.

not exactly the same. As Sommerfeld was able to show, the components this gives for each hydrogen line agree with the observations on the fine structure of hydrogen lines to within the limits of experimental error. In the figure the arrows designate the processes that give rise to the components of the red and green lines in the hydrogen spectrum, the frequencies of which are obtained by putting $n''=2$ and $n'=3$ or 4 respectively in the Balmer formula.

In considering the figure it must not be forgotten that the description of the orbit is there incomplete, in so much as with the scale used the slow precession does not show at all. In fact, this precession is so slow that even for the orbits that rotate most rapidly the electron performs about 40,000 revolutions before the perihelion has gone round once. Nevertheless, it is this precession alone that is responsible for the multiplicity of the stationary states characterised by the subordinate quantum number. If, for example, the hydrogen atom is subjected to a small disturbing force which perturbs the regular precession, the electron orbit in the stationary states will have a form altogether different from that given in the figure. This implies that the fine structure will change its character completely, but the hydrogen spectrum will continue to consist of lines that are given to a close approximation by the Balmer formula, due to the fact that the approximately periodic character of the motion will be retained. Only when the disturbing forces become so large that even during a single revolution of the electron the orbit is appreciably disturbed, will the spectrum undergo essential changes. The statement often advanced that the introduction of two quantum numbers should be a necessary condition for the explanation of the Balmer formula must therefore be considered as a misconception of the theory.

Sommerfeld's theory has proved itself able to account not only for the fine structure of the hydrogen lines, but also for that of the lines in the helium spark spectrum. Owing to the greater velocity of the electron, the intervals between the components into which a line is split up are here much greater and can be measured with much greater accuracy. The theory was also able to account for certain features in the fine structure of X-ray spectra, where we meet frequency differences that may even reach a value more than a million times as great as those of the frequency differences for the components of the hydrogen lines.

Shortly after this result had been attained, Schwarzschild and Epstein (1916) simultaneously succeeded, by means of similar considerations, in accounting for the characteristic changes that the hydrogen lines undergo in an electric field, which had been discovered by Stark in the year 1914. Next, an explanation of the essential features of the Zeeman effect for the hydrogen lines was worked out at the same time by Sommerfeld and Debye (1917). In this instance the application of the Postulates involved the consequence that only certain orientations of the atom relative to the magnetic field were allowable, and this characteristic consequence of the quantum theory has quite recently received a most direct confirmation in the beautiful researches of Stern and Gerlach on the deflexion of swiftly-moving silver atoms in a non-homogenous magnetic field.

The Correspondence Principle.

While this development of the theory of spectra was based on the working out of formal methods for the fixation of stationary states, the present lecturer succeeded shortly afterwards in throwing light on the theory from a new view-point, by pursuing further the characteristic connexion between the quantum theory and classical electrodynamics already traced out in the hydrogen spectrum. In connexion with the important work of Ehrenfest and Einstein these efforts led to the formulation of the so-called *correspondence principle*, according to which the occurrence of transitions between the stationary states accompanied by emission of radiation is traced back to the harmonic components into which the motion

of the atom may be resolved and which, according to the classical theory, determine the properties of the radiation to which the motion of the particles gives rise.

According to the correspondence principle, it is assumed that every transition process between two stationary states can be co-ordinated with a corresponding harmonic vibration component in such a way that the probability of the occurrence of the transition is dependent on the amplitude of the vibration. The state of polarisation of the radiation emitted during the transition depends on the further characteristics of the vibration, in a manner analogous to that in which on the classical theory the intensity and state of polarisation in the wave system emitted by the atom as a consequence of the presence of this vibration component would be determined respectively by the amplitude and further characteristics of the vibration.

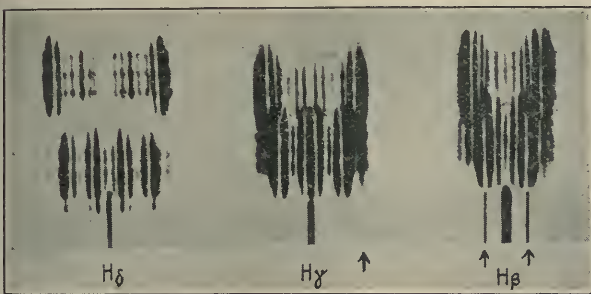

Fig. 6.

With the aid of the correspondence principle it has been possible to confirm and to extend the above-mentioned results. Thus it was possible to develop a complete quantum theory explanation of the Zeeman effect for the hydrogen lines, which, in spite of the essentially different character of the assumptions that underlie the two theories, is very similar throughout to Lorentz's original explanation based on the classical theory. In the case of the Stark effect, where, on the other hand, the classical theory was completely at a loss, the quantum theory explanation could be so extended with the help of the correspondence principle as to account for the polarisation of the different components into which the lines are split, and also for the characteristic intensity distribution exhibited by the components. This last question has been more closely investigated by Kramers, and the accompanying figure will give some impression of how completely it is possible to account for the phenomenon under consideration.

Fig. 6 reproduces one of Stark's well-known photographs of the splitting up of the hydrogen lines. The picture displays very well the varied nature of the phenomenon, and shows in how peculiar a fashion the intensity varies from component to component. The components below are polarised perpendicular to the field, while those above are polarised parallel to the field.

Fig. 7 gives a diagrammatic representation of the experimental and theoretical results for the line Hγ, the frequency of which is given by the Balmer formula with $n''=2$ and $n'=5$. The vertical lines denote the components into which the line is split up, of which the picture on the right gives the components which are polarised parallel to the field and that on the left those that are polarised perpendicular to it. The experimental results are represented in the upper half of the diagram, the distances from the dotted line representing the measured displacements of the components, and the lengths of the lines being proportional to the relative intensity as estimated by Stark from the blackening of the photographic plate. In the lower half is given for comparison a representation of the theoretical results from a drawing in Kramers' paper.

The symbol $(n'_{s'} - n''_{s''})$ attached to the lines gives the transitions between the stationary states of the atom in the electric field by which the components are emitted. Besides the principal quantum integer n, the stationary states are further characterised by a subordinate quantum integer s, which can be negative as well as positive and has a meaning quite different from that of the quantum number k occurring in the relativity theory of the fine structure of the hydrogen lines, which fixed the form of the electron orbit in the undisturbed atom. Under the influence of the electric field both the form of the orbit and its position undergo large changes, but certain properties of the orbit remain unchanged, and the subordinate quantum number s is connected with these. In Fig. 7 the position of the components corresponds to the frequencies calculated for the different transitions, and the lengths of the lines are proportional to the probabilities as calculated on the basis of the correspondence principle, by which also the polarisation of the radiation is determined. It is seen that the theory reproduces completely the main feature of the experimental results, and in the light of the correspondence principle we can say that the Stark effect reflects down to the smallest details the action of the electric field on the orbit of the electron in the hydrogen atom, even though in this case the reflection is so distorted that, in contrast with the case of the Zeeman effect, it would scarcely be possible directly to recognise the motion on the basis of the classical ideas of the origin of electromagnetic radiation.

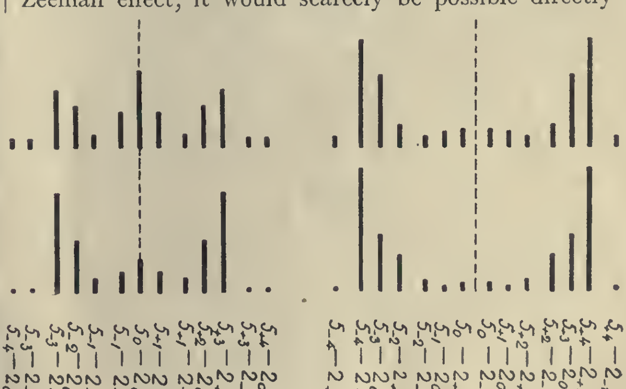

Fig. 7.

Results of interest were also obtained for the spectra of elements of higher atomic number, the explanation of which in the meantime had made important progress through the work of Sommerfeld, who introduced several quantum numbers for the description of the

electron orbits. Indeed, it was possible, with the aid of the correspondence principle, to account completely for the characteristic rules which govern the seemingly capricious occurrence of combination lines, and it is not too much to say that the quantum theory has not only provided a simple interpretation of the combination principle, but has further contributed materially to the clearing up of the mystery that has long rested over the application of this principle.

The same view-points have also proved fruitful in the investigation of the so-called band spectra. These do not originate, as do series spectra, from individual atoms, but from molecules; and the fact that these spectra are so rich in lines is due to the complexity of the motion entailed by the vibrations of the atomic nuclei relative to each other and the rotations of the molecule as a whole. The first to apply the postulates to this problem was Schwarzschild, but the important work of Heurlinger especially has thrown much light on the origin and structure of band spectra. The considerations employed here can be traced back directly to those discussed at the beginning of this lecture in connexion with Bjerrum's theory of the influence of molecular rotation on the infra-red absorption lines of gases. It is true we no longer think that the rotation is reflected in the spectra in the way claimed by classical electrodynamics, but rather that the line components are due to transitions between stationary states which differ as regards rotational motion. That the phenomenon retains its essential features, however, is a typical consequence of the correspondence principle.

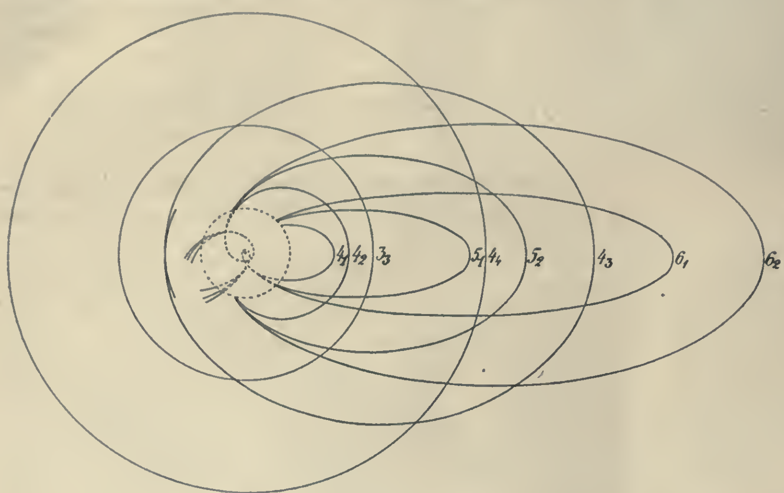

Fig. 8.

The Natural System of the Elements.

The ideas of the origin of spectra outlined in the preceding have furnished the basis for a theory of the structure of the atoms of the elements which has shown itself suitable for a general interpretation of the main features of the properties of the elements, as exhibited in the natural system. This theory is based primarily on considerations of the manner in which the atom can be imagined to be built up by the capture and binding of electrons to the nucleus, one by one. As we have seen, the optical spectra of elements provide us with evidence on the progress of the last steps in this building up process.

An insight into the kind of information that the closer investigation of the spectra has provided in this respect may be obtained from Fig. 8, which gives a diagrammatic representation of the orbital motion in the stationary states corresponding to the emission of the arc-spectrum of potassium. The curves show the form of the orbits described in the stationary states by the last electron captured in the potassium atom, and they can be considered as stages in the process whereby the 19th electron is bound after the 18 previous electrons have already been bound in their normal orbits. In order not to complicate the figure, no attempt has been made to draw any of the orbits of these inner electrons, but the region in which they move is enclosed by a dotted circle. In an atom with several electrons the orbits will, in general, have a complicated character. Because of the symmetrical nature of the field of force about the nucleus, however, the motion of each single electron can be approximately described as a plane periodic motion on which is superimposed a uniform rotation in the plane of the orbit. The orbit of each electron will therefore be to a first approximation doubly periodic, and will be fixed by two quantum numbers, as are the stationary states in a hydrogen atom when the relativity precession is taken into account.

In Fig. 8, as in Fig. 5, the electron orbits are marked with the symbol n_k, where n is the principal quantum number and k the subordinate quantum number. While for the initial states of the binding process, where the quantum numbers are large, the orbit of the last electron captured lies completely outside of those of the previously bound electrons, this is not the case for the last stages. Thus, in the potassium atom, the electron orbits with subordinate quantum numbers 2 and 1 will, as indicated in the figure, penetrate partly into the inner region. Because of this circumstance, the orbits will deviate very greatly from a simple Kepler motion, since they will consist of a series of successive outer loops that have the same size and form, but each of which is turned through an appreciable angle relative to the preceding one. Of these outer loops only one is shown in the figure. Each of them coincides very nearly with a piece of a Kepler ellipse, and they are connected, as indicated, by a series of inner loops of a complicated character in which the electron approaches the nucleus closely. This holds especially for the orbit with subordinate quantum number 1, which, as a closer investigation shows, will approach nearer to the nucleus than any of the previously bound electrons.

On account of this penetration into the inner region, the strength with which an electron in such an orbit is bound to the atom will—in spite of the fact that for the most part it moves in a field of force of the

same character as that surrounding the hydrogen nucleus—be much greater than for an electron in a hydrogen atom that moves in an orbit with the same principal quantum number, the maximum distance of the electron from the nucleus at the same time being considerably less than in such a hydrogen orbit. As we shall see, this feature of the binding process in atoms with many electrons is of essential importance in order to understand the characteristic periodic way in which many properties of the elements as displayed in the natural system vary with the atomic number.

In the accompanying table (Fig. 9) is given a summary of the results concerning the structure of

	1_1	$2_1 2_2$	$3_1 3_2 3_3$	$4_1 4_2 4_3 4_4$	$5_1 5_2 5_3 5_4 5_5$	$6_1 6_2 6_3 6_4 6_5 6_6$	$7_1 7_2$
1 H	1						
2 He	2						
3 Li	2	1					
4 Be	2	2					
5 B	2	2(1)					
— —	—	— —					
10 Ne	2	4 4					
11 Na	2	4 4	1				
12 Mg	2	4 4	2				
13 Al	2	4 4	2 1				
— —	—	— —	— —				
18 A	2	4 4	4 4				
19 K	2	4 4	4 4	1			
20 Ca	2	4 4	4 4	2			
21 Sc	2	4 4	4 4 1	(2)			
22 Ti	2	4 4	4 4 2	(2)			
— —	—	— —	— — —	—			
29 Cu	2	4 4	6 6 6	1			
30 Zn	2	4 4	6 6 6	2			
31 Ga	2	4 4	6 6 6	2 1			
— —	—	— —	— — —	— —			
36 Kr	2	4 4	6 6 6	4 4			
37 Rb	2	4 4	6 6 6	4 4	1		
38 Sr	2	4 4	6 6 6	4 4	2		
39 Y	2	4 4	6 6 6	4 4 1	(2)		
40 Zr	2	4 4	6 6 6	4 4 2	(2)		
— —	—	— —	— — —	— — —	—		
47 Ag	2	4 4	6 6 6	6 6 6	1		
48 Cd	2	4 4	6 6 6	6 6 6	2		
49 In	2	4 4	6 6 6	6 6 6	2 1		
— —	—	— —	— — —	— — —	— —		
54 X	2	4 4	6 6 6	6 6 6	4 4		
55 Cs	2	4 4	6 6 6	6 6 6	4 4	1	
56 Ba	2	4 4	6 6 6	6 6 6	4 4	2	
57 La	2	4 4	6 6 6	6 6 6	4 4 1	(2)	
58 Ce	2	4 4	6 6 6	6 6 6 1	4 4 1	(2)	
59 Pr	2	4 4	6 6 6	6 6 6 2	4 4 1	(2)	
— —	—	— —	— — —	— — — —	— — —	—	
71 Cp	2	4 4	6 6 6	8 8 8 8	4 4 1	(2)	
72 –	2	4 4	6 6 6	8 8 8 8	4 4 2	(2)	
— —	—	— —	— — —	— — — —	— — —	—	
79 Au	2	4 4	6 6 6	8 8 8 8	6 6 6	1	
80 Hg	2	4 4	6 6 6	8 8 8 8	6 6 6	2	
81 Tl	2	4 4	6 6 6	8 8 8 8	6 6 6	2 1	
— —	—	— —	— — —	— — — —	— — —	— —	
86 Em	2	4 4	6 6 6	8 8 8 8	6 6 6	4 4	
87 –	2	4 4	6 6 6	8 8 8 8	6 6 6	4 4	1
88 Ra	2	4 4	6 6 6	8 8 8 8	6 6 6	4 4	2
89 Ac	2	4 4	6 6 6	8 8 8 8	6 6 6	4 4 1	(2)
90 Th	2	4 4	6 6 6	8 8 8 8	6 6 6	4 4 2	(2)
— —	—	— —	— — —	— — — —	— — —	— — —	—
118 ?	2	4 4	6 6 6	8 8 8 8	8 8 8 8	6 6 6	4 4

Fig. 9.

the atoms of the elements to which the author has been led by a consideration of successive capture and binding of electrons to the atomic nucleus. The figures before the different elements are the atomic numbers, which give the total number of electrons in the neutral atom. The figures in the different columns give the number of electrons in orbits corresponding to the values of the principal and subordinate quantum numbers standing at the top. In accordance with ordinary usage we will, for the sake of brevity, designate an orbit with principal quantum number n as an n-quantum orbit. The first electron bound in each atom moves in an orbit that corresponds to the normal state of the hydrogen atom with quantum symbol 1_1. In the hydrogen atom there is of course only one electron; but we must assume that in the atoms of other elements the next electron also will be bound in such a 1-quantum orbit of type 1_1. As the table shows, the following electrons are bound in 2-quantum orbits. To begin with, the binding will result in a 2_1 orbit, but later electrons will be bound in 2_2 orbits, until, after binding the first 10 electrons in the atom, we reach a closed configuration of the 2-quantum orbits in which we assume there are four orbits of each type. This configuration is met for the first time in the neutral neon atom, which forms the conclusion of the second period in the system of the elements. When we proceed in this system, the following electrons are bound in 3-quantum orbits, until, after the conclusion of the third period of the system, we encounter for the first time, in elements of the fourth period, electrons in 4-quantum orbits, and so on.

This picture of atomic structure contains many features that were brought forward by the work of earlier investigators. Thus the attempt to interpret the relations between the elements in the natural system by the assumption of a division of the electrons into groups goes as far back as the work of J. J. Thomson in 1904. Later, this view-point was developed chiefly by Kossel (1916), who, moreover, has connected such a grouping with the laws that investigations of X-ray spectra have brought to light.

Also G. R. Lewis and I. Langmuir have sought to account for the relations between the properties of the elements on the basis of a grouping inside the atom. These investigators, however, assumed that the electrons do not move about the nucleus, but occupy positions of equilibrium. In this way, though, no closer relation can be reached between the properties of the elements and the experimental results concerning the constituents of the atoms. Statical positions of equilibrium for the electrons are in fact not possible in cases in which the forces between the electrons and the nucleus even approximately obey the laws that hold for the attractions and repulsions between electrical charges.

The possibility of an interpretation of the properties of the elements on the basis of these latter laws is quite characteristic for the picture of atomic structure developed by means of the quantum theory. As regards this picture, the idea of connecting the grouping with a classification of electron orbits according to increasing quantum numbers was suggested by Moseley's discovery of the laws of X-ray spectra, and by Sommerfeld's work on the fine structure of these spectra. This has been principally emphasised by Vegard, who some years ago in connexion with investigations of X-ray spectra proposed a grouping of electrons in the atoms of the elements, which in many ways shows a likeness to that which is given in the above table.

A satisfactory basis for the further development of this picture of atomic structure has, however, only recently been created by the study of the binding

processes of the electrons in the atom, of which we have experimental evidence in optical spectra, and the characteristic features of which have been elucidated principally by the correspondence principle. It is here an essential circumstance that the restriction on the course of the binding process, which is expressed by the presence of electron orbits with higher quantum numbers in the normal state of the atom, can be naturally connected with the general condition for the occurrence of transitions between stationary states, formulated in that principle.

Another essential feature of the theory is the influence, on the strength of binding and the dimensions of the orbits, of the penetration of the later bound electrons into the region of the earlier bound ones, of which we have seen an example in the discussion of the origin of the potassium spectrum. Indeed, this circumstance may be regarded as the essential cause of the pronounced periodicity in the properties of the elements, in that it implies that the atomic dimensions and chemical properties of homologous substances in the different periods, as, for example, the alkali-metals, show a much greater similarity than that which might be expected from a direct comparison of the orbit of the last electron bound with an orbit of the same quantum number in the hydrogen atom.

The increase of the principal quantum number which we meet when we proceed in the series of the elements, affords also an immediate explanation of the characteristic deviations from simple periodicity which are exhibited by the natural system and are expressed in Fig. 1 by the bracketing of certain series of elements in the later periods. The first time such a deviation is met with is in the 4th period, and the reason for it can be simply illustrated by means of our figure of the orbits of the last electron bound in the atom of potassium, which is the first element in this period. Indeed, in potassium we encounter for the first time in the sequence of the elements a case in which the principal quantum number of the orbit of the last electron bound is, in the normal state of the atom, larger than in one of the earlier stages of the binding process. The normal state corresponds here to a 4_1 orbit, which, because of the penetration into the inner region, corresponds to a much stronger binding of the electron than a 4-quantum orbit in the hydrogen atom. The binding in question is indeed even stronger than for a 2-quantum orbit in the hydrogen atom, and is therefore more than twice as strong as in the circular 3_3 orbit which is situated completely outside the inner region, and for which the strength of the binding differs but little from that for a 3-quantum orbit in hydrogen.

This will not continue to be true, however, when we consider the binding of the 19th electron in substances of higher atomic number, because of the much smaller relative difference between the field of force outside and inside the region of the first eighteen electrons bound. As is shown by the investigation of the spark spectrum of calcium, the binding of the 19th electron in the 4_1 orbit is here but little stronger than in 3_3 orbits, and as soon as we reach scandium, we must assume that the 3_3 orbit will represent the orbit of the 19th electron in the normal state, since this type of orbit will correspond to a stronger binding than a 4_1 orbit. While the group of electrons in 2-quantum orbits has been entirely completed at the end of the 2nd period, the development that the group of 3-quantum orbits undergoes in the course of the 3rd period can therefore only be described as a provisional completion, and, as shown in the table, this electron group will, in the bracketed elements of the 4th period, undergo a stage of further development in which electrons are added to it in 3-quantum orbits.

This development brings in new features, in that the development of the electron group with 4-quantum orbits comes to a standstill, so to speak, until the 3-quantum group has reached its final closed form. Although we are not yet in a position to account in all details for the steps in the gradual development of the 3-quantum electron group, still we can say that with the help of the quantum theory we see at once why it is in the 4th period of the system of the elements that there occur for the first time successive elements with properties that resemble each other as much as the properties of the *iron group*; indeed, we can even understand why these elements show their well-known paramagnetic properties. Without further reference to the quantum theory, Ladenburg had on a previous occasion already suggested the idea of relating the chemical and magnetic properties of these elements with the development of an inner electron group in the atom.

I will not enter into many more details, but only mention that the peculiarities we meet with in the 5th period are explained in much the same way as those in the 4th period. Thus the properties of the bracketed elements in the 5th period as it appears in the table, depend on a stage in the development of the 4-quantum electron group that is initiated by the entrance in the normal state of electrons in 4_3 orbits. In the 6th period, however, we meet new features. In this period we encounter not only a stage of the development of the electron groups with 5- and 6-quantum orbits, but also the final completion of the development of the 4-quantum electron group, which is initiated by the entrance for the first time of electron orbits of the 4_4 type in the normal state of the atom. This development finds its characteristic expression in the occurrence of the peculiar family of elements in the 6th period, known as the *rare-earths*. These show, as we know, a still greater mutual similarity in their chemical properties than the elements of the iron family. This must be ascribed to the fact that we have here to do with the development of an electron group that lies deeper in the atom. It is of interest to note that the theory can also naturally account for the fact that these elements, which resemble each other in so many ways, still show great differences in their magnetic properties.

The idea that the occurrence of the rare-earths depends on the development of an inner electron group has been put forward from different sides. Thus it is found in the work of Vegard, and at the same time as my own work, it was proposed by Bury in connexion with considerations of the systematic relation between the chemical properties and the grouping of the electrons inside the atom from the point of view of Langmuir's static atomic model. While

until now it has not been possible, however, to give any theoretical basis for such a development of an inner group, we see that our extension of the quantum theory provides us with an unforced explanation. Indeed, it is scarcely an exaggeration to say that if the existence of the rare-earths had not been established by direct chemical investigation, the occurrence of a family of elements of this character within the 6th period of the natural system of the elements might have been theoretically predicted.

When we proceed to the 7th period of the system, we meet for the first time with 7-quantum orbits, and we shall expect to find within this period features that are essentially similar to those in the 6th period, in that besides the first stage in the development of the 7-quantum orbits, we must expect to encounter further stages in the development of the group with 6- or 5-quantum orbits. However, it has not been possible directly to confirm this expectation, because only a few elements are known in the beginning of the 7th period. The latter circumstance may be supposed to be intimately connected with the instability of atomic nuclei with large charges, which is expressed in the prevalent radioactivity among elements with high atomic number.

X-ray Spectra and Atomic Constitution.

In the discussion of the conceptions of atomic structure we have hitherto placed the emphasis on the formation of the atom by successive capture of electrons. Our picture would, however, be incomplete without some reference to the confirmation of the theory afforded by the study of X-ray spectra. Since the interruption of Moseley's fundamental researches by his untimely death, the study of these spectra has been continued in a most admirable way by Prof. Siegbahn in Lund. On the basis of the large amount of experimental evidence adduced by him and his collaborators, it has been possible recently to give a classification of X-ray spectra that allows an immediate interpretation on the quantum theory. In the first place it has been possible, just as in the case of the optical spectra, to represent the frequency of each of the X-ray lines as the difference between two out of a manifold of spectral terms characteristic of the element in question. Next, a direct connexion with the atomic theory is obtained by the assumption that each of these spectral terms multiplied by Planck's constant is equal to the work which must be done on the atom to remove one of its inner electrons. In fact, the removal of one of the inner electrons from the completed atom may, in accordance with the above considerations on the formation of atoms by capture of electrons, give rise to transition processes by which the place of the electron removed is taken by an electron belonging to one of the more loosely bound electron groups of the atom, with the result that after the transition an electron will be lacking in this latter group.

The X-ray lines may thus be considered as giving evidence of stages in a process by which the atom undergoes a *reorganisation* after a disturbance in its interior. According to our views on the stability of the electronic configuration such a disturbance must consist in the total removal of electrons from the atom, or at any rate in their transference from normal orbits to orbits of higher quantum numbers than those belonging to completed groups; a circumstance which is clearly illustrated in the characteristic difference between selective absorption in the X-ray region, and that exhibited in the optical region.

The classification of the X-ray spectra, to the achievement of which the above-mentioned work of Sommerfeld and Kossel has contributed materially, has recently made it possible, by means of a closer examination of the manner in which the terms occurring in the X-ray spectra vary with the atomic number, to obtain a very direct test of a number of the theoretical

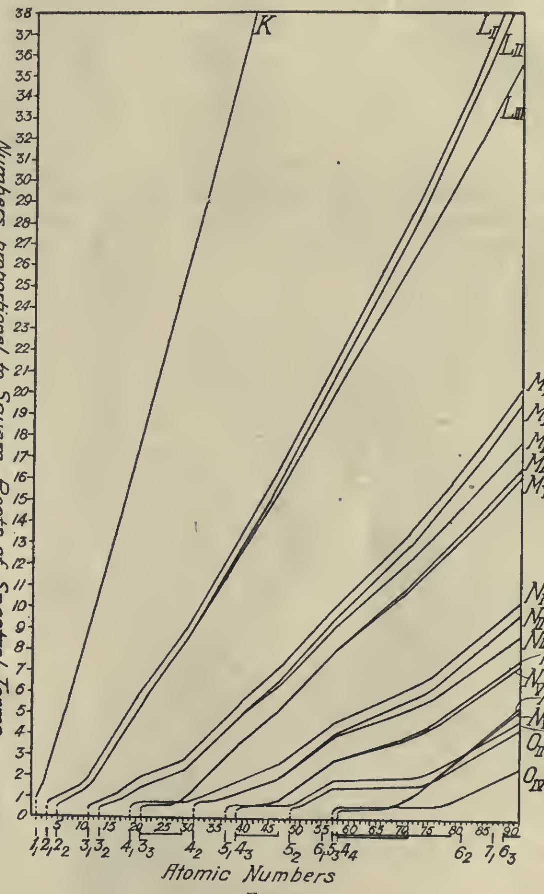

Fig. 10.

conclusions as regards the structure of the atom. In Fig. 10 the abscissæ are the atomic numbers and the ordinates are proportional to the square roots of the spectral terms, while the symbols K, L, M, N, O, for the individual terms refer to the characteristic discontinuities in the selective absorption of the elements for X-rays; these were originally found by Barkla before the discovery of the interference of X-rays in crystals had provided a means for the closer investigation of X-ray spectra. Although the curves generally run very uniformly, they exhibit a number of deviations from uniformity which have been especially brought to light by the recent investigation of Coster, who has for some years worked in Siegbahn's laboratory.

These deviations, the existence of which was not discovered until after the publication of the theory

of atomic structure discussed above, correspond exactly to what one might expect from this theory. At the foot of the figure the vertical lines indicate where, according to the theory, we should first expect, in the normal state of the atom, the occurrence of n_k orbits of the type designated. We see how it has been possible to connect the occurrence of every spectral term with the presence of an electron moving in an orbit of a definite type, to the removal of which this term is supposed to correspond. That in general there corresponds more than one curve to each type of orbit n_k is due to a complication in the spectra which would lead us too far afield to enter into here, and may be attributed to the deviation from the previously described simple type of motion of the electron arising from the interaction of the different electrons within the same group.

The intervals in the system of the elements, in which a further development of an inner electron group takes place because of the entrance into the normal atom of electron orbits of a certain type, are designated in the figure by the horizontal lines, which are drawn between the vertical lines to which the quantum symbols are affixed. It is clear that such a development of an inner group is everywhere reflected in the curves. Particularly the course of the N- and O-curves may be regarded as a direct indication of that stage in the development of the electron groups with 4-quantum orbits of which the occurrence of the rare-earths bears witness. Although the apparent complete absence of a reflection in the X-ray spectra of the complicated relationships exhibited by most other properties of the elements was the typical and important feature of Moseley's discovery, we can recognise, nevertheless, in the light of the progress of the last years, an intimate connexion between the X-ray spectra and the general relationships between the elements within the natural system.

Before concluding this lecture I should like to mention one further point in which X-ray investigations have been of importance for the test of the theory. This concerns the properties of the hitherto unknown element with atomic number 72. On this question opinion has been divided in respect to the conclusions that could be drawn from the relationships within the periodic table, and in many representations of the table a place is left open for this element in the rare-earth family. In Julius Thomsen's representation of the natural system, however, this hypothetical element was given a position homologous to titanium and zirconium in much the same way as in our representation in Fig. 1. Such a relationship must be considered as a necessary consequence of the theory of atomic structure developed above, and is expressed in the table (Fig. 9) by the fact that the electron configurations for titanium and zirconium show the same sort of resemblances and differences as the electron configurations for zirconium and the element with atomic number 72. A corresponding view was proposed by Bury on the basis of his above-mentioned systematic considerations of the connexion between the grouping of the electrons in the atom and the properties of the elements.

Recently, however, a communication was published by Dauvillier announcing the observation of some weak lines in the X-ray spectrum of a preparation containing rare-earths. These were ascribed to an element with atomic number 72 assumed to be identical with an element of the rare-earth family, the existence of which in the preparation used had been presumed by Urbain many years ago. This conclusion would, however, if it could be maintained, place extraordinarily great, if not unsurmountable, difficulties in the way of the theory, since it would claim a change in the strength of the binding of the electrons with the atomic number which seems incompatible with the conditions of the quantum theory. In these circumstances Dr. Coster and Prof. Hevesy, who are both for the time working in Copenhagen, took up a short time ago the problem of testing a preparation of zircon-bearing minerals by X-ray spectroscopic analysis. These investigators have been able to establish the existence in the minerals investigated of appreciable quantities of an element with atomic number 72, the chemical properties of which show a great similarity to those of zirconium and a decided difference from those of the rare-earths.[2]

I hope that I have succeeded in giving a summary of some of the most important results that have been attained in recent years in the field of atomic theory, and I should like, in concluding, to add a few general remarks concerning the view-point from which these results may be judged, and particularly concerning the question of how far, with these results, it is possible to speak of an explanation, in the ordinary sense of the word. By a theoretical explanation of natural phenomena we understand in general a classification of the observations of a certain domain with the help of analogies pertaining to other domains of observation, where one presumably has to do with simpler phenomena. The most that one can demand of a theory is that this classification can be pushed so far that it can contribute to the development of the field of observation by the prediction of new phenomena.

When we consider the atomic theory, we are, however, in the peculiar position that there can be no question of an explanation in this last sense, since here we have to do with phenomena which from the very nature of the case are simpler than in any other field of observation, where the phenomena are always conditioned by the combined action of a large number of atoms. We are therefore obliged to be modest in our demands and content ourselves with concepts which are formal in the sense that they do not provide a visual picture of the sort one is accustomed to require of the explanations with which natural philosophy deals. Bearing this in mind I have sought to convey the impression that the results, on the other hand, fulfil, at least in some degree, the expectations that are entertained of any theory; in fact, I have attempted to show how the development of atomic theory has contributed to the classification of extensive fields of observation, and by its predictions has pointed out the way to the completion of this classification. It is scarcely necessary, however, to emphasise that the theory is yet in a very preliminary stage, and many fundamental questions still await solution.

[2] For the result of the continued work of Coster and Hevesy with the new element, for which they have proposed the name hafnium, the reader may be referred to their letters in NATURE of January 20, February 10 and 24, and April 7.

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Training for the Industrial Professions.

IN the formation of the great professional corporations of industrial intellect it is evident that there must be some condition of entry which shall make for a certain uniformity and shall satisfy the requirements of existing members. The essential principle on which all agree is that there must be proof of an adequate education in theory, along with a sufficient and comprehensive training in practice. This combination is ensured in various ways, but for those who aim at securing the hall-mark of inclusion within the appropriate professional institution there is now in Great Britain a scale of reasonably comparable requirements, based in every instance upon a proof of soundness of general and scientific education, with a guarantee at each stage that progressive professional or technical experience is being simultaneously acquired.

Schemes of this type have been adopted by the Institute of Chemistry, and the Institutions of Civil, Mechanical, and Electrical Engineers, among others. Qualification to register as student is given either by success in a special examination held by the institution concerned, or by production of evidence of having passed some recognised equivalent, such as the Matriculation examination of a university; and, in this connexion, it is interesting to note that among the requirements there is now in every case, in addition to a proved knowledge of science, a demand for a good training in English, and, at some stage, for knowledge of one foreign language.

Having thus entered, the student, with increase of experience, is led to further tests, and, with these satisfied and under the personal recommendation of those professionally competent, he may pass forward at appropriate ages to Graduateship, to Associate Membership, and in the end to full Membership of the institution chosen.

The subject-matter of these further examinations is almost entirely technical, and has to deal with the specialised knowledge required for the particular profession; but again, in lieu of this special examination, it is permissible to offer a recognised and approved equivalent in the shape of the degree of an approved university, or the diploma of an approved college. There is, as the student advances in his career, a gradual elimination of demand for those subjects which may be studied mainly for educational training in favour of those which are of direct professional importance.

The course of education and training followed is to give the power both to work and to think, ability not only to carry into performance with intelligence instructions given, but also to see possibilities of new design or process.

The success of this method adopted for the creation of a highly qualified and well-acknowledged directorate has been most evident, conspicuous alike in home employment and in foreign and colonial engagement. Certain broad principles have been laid down and enforced to ensure that a course of study, coupled with practical training properly supervised, has produced a satisfactory and prescribed result, and, in order to maintain for the corporate body a voice of accepted authority, the strictest conditions of admission have been enforced.

Until recently it has been with this part of the problem of training that the great engineering and chemical institutions have been principally concerned. Realising the vast potentialities and responsibilities of their professions, they have rightly demanded from those desirous of entering the highest qualifications obtainable. The direction of scientific industry has risen to demand the fullest knowledge of the relevant sciences; and it is to ensure the possession of this knowledge that each institution, jealous of its entrants, has laid down examinational tests which have been carefully considered by practical experts, and bear considerable weight in the formulation of higher schemes of study.

In every industry, however, it has to be recognised that success comes not alone through the guidance of a trained, well-informed, and open-eyed directorate, but that there must be also an adequate supply of skilled and educated under-officers and men. It is therefore of the greatest interest to notice the recent extension of activity of several of these high professional associations, which, with the assistance and active co-operation of the Board of Education, have now taken within their purview schemes of study and examination whereby opportunity of close association with the professional body is given to those skilled or scientific workers who are ready to devote the time requisite to follow an approved course of theoretical study, which for the National Certificates may be taken in evening or part-time classes.

It is to be hoped that this further advance, recognising unity of interest and consequent inter-dependence between the professional worker and those actually engaged in the operations of production, may lead to the creation of a band of officers of industry, competent to undertake the effective direction of one or more of the many departments into which the fabric of a great industrial undertaking is now divided, or to come forward to take charge at a call of emergency.

There can be no doubt that we have in this new and wider outlook, which has been brought about by wise co-operation of the highest representatives of our great industries with the Board of Education, a possibility of most far-reaching consequence, likely not only to influence with advantage the whole provision of relevant educational opportunity, but also to produce a far wider moral and psychological effect upon the worker, who will in this way be able to see opportunity of clearer relationship within one body between the man of directing professional qualification and himself.

British scientific industry has often in the past suffered from want of this association, and it is to be hoped that other professional institutions with industrial purpose may feel able to follow the enlightened example of those which have instituted a movement likely to bear the best of fruit.

A special feature of the schemes of collaboration so far arranged by the Institution of Mechanical Engineers, the Institution of Electrical Engineers, and the Institute of Chemistry with the Board of Education for the issue of National Certificates and Diplomas is the guarantee of standard vouched for by the appropriate institution in conjunction with the Board, along with the allowance of reasonable variation in arrangement of the subject-matter of the approved courses to ensure satisfaction of the needs of local trade specialisation. The examinations are conducted locally but under the surveillance of appointed central assessors. Certificates and Diplomas thus authenticated should be able to claim world-wide acceptance of value where similar work is required to be undertaken, while the schemes should give to the several institutions a most valuable means of encouragement towards the training of the higher grades of supervisory workers.

Evolution and Christian Faith.

(1) *Evolution and Christian Faith.* By Prof. H. H. Lane. Pp. xi+214. (Princeton: Princeton University Press; London: Oxford University Press, 1923.) 9*s*. net.

(2) *Origin and Evolution of Religion.* By Prof. E. Washburn Hopkins. Pp. v+370. (New Haven: Yale University Press; London: Oxford University Press, 1923.) 15*s*. net.

THE two books before us are of interest not only in themselves but also as illustrating important types of mental activity in America. Both books deal with religion. Yet the author of one is a professor of zoology and of the other a professor of Sanskrit. Prof. Lane writes from the Christian point of view, and combines an expert knowledge of biology with religious earnestness. His work is the outcome of a series of lectures in which he was asked by students to describe the theory of evolution and the salient facts on which it is based, and to discuss the effect of accept-

ance of the theory on "one's views of the Biblical account of Creation and of the Christian religion." Prof. Hopkins, on the other hand, is not a Christian apologist, but plainly sympathises with the religious syncretism which is not uncommon among American intellectuals. He seeks to disclose and, we suggest, sometimes exaggerates likenesses to be found in the advanced religions of mankind. He uses a singularly wide survey of the religious development of humanity to indicate the sort of faith which may emerge from the present clash of creeds and philosophies. He is learned, urbane, and detached.

Though the writers of the two books thus differ widely, they represent parallel developments of a characteristically modern movement. Throughout the nineteenth century there was a continuous battle between science and theology, or, to speak more definitely, between certain assumptions associated with but not essential to the Christian faith and the contradictory conclusions reached by modern investigation. Such a conflict was inevitable, for, as Prof. Gilbert Murray has justly said, the progress of human knowledge has been four times as rapid during the last hundred years as during any century since the Christian era began. The conflict, moreover, could have but one end: it necessarily resulted in the victory of "science." But, however complete the victory, the fact and value of religion remain. So it was to be expected that the victors themselves, once their triumph was assured, would turn to formulate an intellectual basis for religion. As the books before us indicate, they are now making their contribution to the restatement of theology; and theologians, learning from them, are using their own special knowledge for the same purpose.

It is well to insist that each type of specialist is needed for the work. Just as theologians half a century ago were contemptuous of the knowledge won by men of science, so now the latter often fail to realise that from the modern theologian there is much to be learnt. For lack of a theological training, the man of science who is a Christian is always in danger of stumbling into some form of "popular orthodoxy" which the theologian would repudiate. The scholar or man of science, unfamiliar with Christian theology, may easily make false generalisations from isolated statements, and, not seeing the wood for the trees, may lose sight of the essential features of the Christian *Weltanschauung*.

It is necessary to emphasise that Christianity is a synthesis. It is built upon the Gospels and their central Figure; and, of course, behind His teaching lay Jewish ethical monotheism. But the classical Creeds were developed by combining this basis with Greek philosophy and, especially, with ideas derived from Plato. In particular, it is assumed that goodness, beauty, and wisdom are absolute values: that they express the spiritual nature of the universe: that, because they have eternal value, they have eternal existence. The real world is thus the spiritual world, where these values exist eternally; and this world of ours is but an imperfect copy of a perfect archetype. Obviously the Gospel and this philosophico-religious setting form a harmony. Modern Christian theologians contend that this harmonious structure gains in strength when into it the conclusions of modern science are built. If, as we believe, they are right, changes due to modern discovery will not harm the fundamentals of Christianity, though some types of cherished picture-thinking will become obsolete.

(1) We will not attempt to describe Prof. Lane's "Evolution and Christian Faith." The main outlines of his argument will be familiar to all who have given some attention to the subject. As is common with American authors, he pays more regard to works by his own countrymen than to those of British thinkers. He writes clearly and argues fairly; and his book may be commended to those who desire to give to the science-student a clear perception of the inadequacy of materialism as a philosophy. He occasionally stumbles when he ventures outside his own realm of biology. For example, he says that Galileo, after 1632, "was thrown into prison, [and] treated with all the severity which his remorseless persecutors could devise, for the remaining ten years of his life." He obviously derives this statement from Draper's "Conflict between Religion and Science." It is inaccurate. In White's "Warfare of Science with Theology" there is a more exact account, with numerous references, of the persecution of Galileo. It was a deplorable business, but not quite so bad as Prof. Lane suggests.

To take another example, Prof. Lane, in writing of the Genesis accounts of Creation, reveals that Biblical scholarship is to him largely a *terra incognita*. He assumes that Moses is the author of the two cosmogonies of which fragments are preserved; and somewhat naïvely suggests that a modern "interpretation does not in any way convict Moses of ignorance nor deceit." Of course, the familiar first chapter of Genesis is a product of Jewish speculation of the time of the exile; and, though the second account of Creation may be some three centuries earlier, it comes from a document which no unprejudiced scholar would assign to Moses himself.

Prof. Lane does not clearly state his view of the nature of Biblical inspiration; and one might read his book without suspecting that he has any doubts as to the substantial infallibility of Scripture. With

regard to miracles he suggests that they may be "in accord with some higher law of which the human mind can at present, at least, form no conception." But he is led from this legitimate belief to ascribe to Christ "knowledge which infinitely transcends our human powers." Such a view, though common, is heretical, because it impairs the perfect humanity of Christ. The orthodox formula, "very God and very Man," is both more subtle and more reasonable than is popularly realised.

Just as the technical theologian might demur to some of Prof. Lane's teaching, so the physicist might ask him to enunciate "the law of gravitation," which "holds universally in nature." But few who try to cover the ground over which the author moves could escape all its pitfalls. Taken as a whole, his work is an admirable defence of the position that there is no inherent antagonism between Christian theism and the biological doctrine of evolution. In England, save by Roman Catholics or extreme Protestants, the position is now generally accepted by Christians. Moreover, an increasing number of men of science recognise that evolution affords no secure basis for a materialist philosophy. As an interpretation of the facts presented by Nature and human nature, such systems as Haeckel's materialistic monism are inadequate. Philosophers, using all such facts, normally work towards theism or pantheism. English divines have not been slow to point out that the conclusions of modern science harmonise with the Christian outlook on human life and with the Christian interpretation of the universe. But in America there is still a widespread belief that evolution is destructive of the Christian faith.

Prof. Lane gives some amazing illustrations of the extent and effects of this mistaken fear. Mr. W. J. Bryan has led a campaign against evolution, the echoes of which are still reverberating from press and pulpit in the Middle Western States. Great religious congresses have declared evolution a "heresy." "The state of Kentucky came near enacting a law forbidding the teaching of this scientific doctrine in any school supported by public funds." A generation ago it seemed as if the Western World had finally escaped from the temper which led the Inquisition to hand over Giordano Bruno to be burnt. But the spectacle is now before us of a great democracy aflame with religious prejudice. Naturally, religion is being gravely harmed. Extreme Protestant and Roman Catholic seminaries get their supply of enthusiastic recruits, for fanaticism breeds a certain type of faith and devotion. But young men whose minds are open to the thought of the time are distracted or repelled by the conflict around them. Some believe their religious teachers; accept the view that evolution makes atheists—and become atheists. Others naturally resolve to find elsewhere than in the Christian ministry an outlet for their aspirations.

Doubtless many causes contribute to the religious obscurantism prevalent in America. But it is safe to say that one of the most effective is the bold, and sometimes extravagant, philosophico-religious speculation common in American universities. Partly owing to its mixed population and partly because of its geographical position between Europe and Asia, America produces learned men less sensitive than our own to the value of the Christian tradition. They try to survey with impartial superiority the varied manifestations of the religious spirit in Europe and Asia. They are aware of the intellectual poverty of much popular Christian thought. They view with cold and contemptuous detachment the strange and novel cults of which their own country is singularly prolific. They are attracted by the philosophical subtlety of Hindu speculation, and probably have no first-hand experience of the moral corruptions which pantheism shelters. The general effect of their teaching is rightly felt by ordinary men and women to be destructive of all religious certainty.

(2) Prof. Hopkins's "Origin and Evolution of Religion" is the sort of book to excite reactionary prejudice, for the half-educated reader will merely perceive that its values are wrong. To us it appears a mixture of wide learning and confused thought. The author gives an illuminating account of primitive religion as disclosed by modern anthropological research. As professor of Sanskrit at Yale, he naturally writes with authority of the development of Aryan religious ideas in India. He describes at length the evolution of Buddhism. He sketches the conflict, among the Greeks and Hebrews, between primitive religious beliefs and finer types of philosophico-spiritual understanding. "In Greece, a moral philosophy gradually developed apart from the gods. The Hebrews alone united ethics, religion, and an anti-polytheistic philosophy." He gives an account of the evolution of Christian theology which we find unsatisfactory. In his pages the complex movement which united Neo-Platonism to the Gospels is inadequately presented. Probably misrepresentation is inevitable in an author who can write that "it makes no religious difference whether God is regarded as essentially quite apart from or immanent in nature."

Prof. Hopkins, setting aside the Christian belief in absolute values, gives us utilitarian ethics. "The ethical law in respect of taking life is not *Thou shalt not kill* but *Thou shalt kill*, when killing aids the group. That is the reason why it was right to kill

an Englishman in 1776 and a German in 1918 till November 11." Obviously it is impossible to place such teaching in the Christian scheme. But we do not see how it can be reconciled with the position which Prof. Hopkins finally reaches. "Whether called divine or not, one controlling conscious intelligence appears to exert its will towards the realisation of a moral ideal in which we participate." It seems to us that, if the implications of this conclusion are developed, the main postulates of Christian Platonism must be accepted. Such, at any rate, is the contention of some of our foremost English theologians. Men of science, interested in these matters, should study the *Confessio Fidei* which appears at the beginning of the second series of Dean Inge's "Outspoken Essays." They will find there no scientific obscurantism, and, at the same time, a powerful discrimination between the ethico-religious values of theism and pantheism which Prof. Hopkins might study with advantage.

E. W. BARNES.

Bacteria of the Soil.

Agricultural Bacteriology. By Prof. J. E. Greaves. Pp. 437. (London: Constable and Co. Ltd., 1922.) 21*s.* net.

WITH the large increase in agricultural experiment stations throughout the world, and with the growth in size and activity of such older stations as Rothamsted within the last ten years, there has been produced a vast amount of work dealing with the activities of bacteria in the soil, their relations to soil fertility, and the influence upon them of external conditions such as manurial treatment. Much of this work is disconnected, and suffers from a want of correlation with our knowledge of related subjects. There is a need, therefore, for text-books that will set in order the facts now established and point out the lines of development which our present knowledge is opening up.

Prof. Greaves has produced a book designed, not primarily for the expert, but to stimulate curiosity and inquiry in the student. The first portion is devoted to general bacteriology, discussing the morphology and schemes for the classification of bacteria, their chemical composition and physiology, and the influence upon them of external conditions such as temperature, heat, disinfectants, and salts. This is a very desirable arrangement, especially since the branches of applied bacteriology are to-day suffering from the backwardness of our knowledge of the fundamental problems of pure bacteriology. One feels, indeed, that the author would have done well to have emphasised more strongly the directions in which such knowledge is most needed. He has also included in this general section such subjects as the influence of heat, volatile antiseptics, and arsenic on soil bacterial activities. It would seem more reasonable to deal with these matters in connexion with the soil population, since the facts do not indicate a simple issue between the soil bacteria and the disinfecting agent.

The middle portion of the book deals with the soil flora and its activities, such as the production of ammonia and nitrate, the fixation of nitrogen, denitrification, cellulose decomposition, and the solvent action of bacterial metabolic products on soil minerals. At the conclusion are chapters on the relation of bacteria to water supply, sewage, dairying, food preservation, and various technical processes.

The completeness with which our present knowledge has been presented, varies very greatly in different parts of the volume. The most interesting part of the work is that which deals with the fixation of atmospheric nitrogen, where the main aspects of the subject are well put forward. Unfortunately, however, reference is omitted to some fundamental work on the soil micro-population without a knowledge of which the student cannot obtain a true picture of the activities of bacteria in the soil. Essential to this, for example, is some knowledge of recent work on the relation between bacterial numbers and the active protozoan fauna in field soil. In criticising Russell and Hutchinson's phagocyte theory of partial sterilisation, the author even states that "the work of Russell and Hutchinson does not consider the probability of the protozoa being in the soil as cysts." The existence of active protozoa in the soil was discovered by Martin and Lewin at Rothamsted in 1915, and, in the protozoology department, initiated there to investigate this subject, it has since been shown by Cutler and Crump (1920) that the numbers of active amœbæ and flagellates in field soil change from day to day, and that the increase and decrease of certain active amœbæ bear an inverse relationship to changes in bacterial numbers. The connexion between active protozoa and bacterial numbers is, therefore, established, with the consequent probability that, if this equilibrium be upset by some partial sterilisation process, such changes would ensue as were found by Russell and Hutchinson.

Again, in connexion with the production of ammonia from organic nitrogen compounds in the soil, the author does not emphasise how important is the nature of the energy supply available to the ammonifying organisms, which, apparently, are equally able to derive their energy from a non-nitrogenous source, and, where such compounds are available, may even assimilate ammonia and nitrate, thus causing a temporary loss of these compounds from the soil. The importance of this factor was pointed out by Doryland (1916). In the chapter on the decomposition of cellulose, there is no

reference to the work, at Rothamsted, of Hutchinson and Clayton (1919) on the remarkable *Spirochæta cytophaga*, which led to a study by Hutchinson and Richards of aerobic cellulose decomposition as a whole, resulting in a process, now in practical use, for making artificial farmyard manure from straw.

It is admittedly impossible, in a book of this type, to cover all the work on bacteria in relation to agriculture, but, as this is the case, it would seem a pity that valuable space should have been given to such unimportant matter as, for example, the fanciful history of an individual phosphorus atom (p. 185).

The author has decided not to give references to literature quoted, but instead gives three or four papers with each chapter, which are selected as containing fuller references to the subject. In many cases, however, a student would find it difficult and sometimes impossible to trace the literature of work mentioned in the text. This, in the reviewer's opinion, is a serious defect. A text-book of this type, even though it be intended merely " to stimulate curiosity and inquiry," should, if it fulfils this purpose, lead the inquirer to a more intimate study of the subject, and, as stepping-stones to this more complete knowledge, good references to literature are essential.

There are some statements in the book which, through inadvertence, are incorrect or misleading. Thus it is stated (p. 35) that nitrogen-fixing bacteria must have atmospheric nitrogen and oxygen, but, in fact, some are anaerobic and probably all can utilise combined nitrogen where this is available. Again, the author says (p. 34) that " *most* plants cannot use nitrogen in the form of ammonia; it must be in the form of nitrates." But Hutchinson and Miller (1909) and also Prianischnikov (1916) found a considerable variety of plants that could utilise ammonia, and Hesselmann (1917) found forest soils that were devoid of bacteria capable of producing nitrate. These examples could be multiplied. Prof. Greaves has planned an interesting book, which, however, could be much more useful if some of the less important matter were omitted so that the present extent of our knowledge could be more completely covered. H. G. Thornton.

The Latin Works of Geber.

Die Alchemie des Geber. Übersetzt und erklärt von Dr. Ernst Darmstädter. Pp. x+202. (Berlin: Julius Springer, 1922.) 10*s*.

In this book Dr. Darmstädter has given a German translation of the " Summa perfectionis," " Liber de investigatione perfectionis," " Liber de inventione veritatis sive perfectionis," " Liber fornacum," and " Testamentum Geberi," mainly, as regards the first four, from the edition published at Nuremberg in 1541. The texts of the Testamentum employed are those of the editions of Venice, 1542, and Danzig, 1682. The translator has included also an introduction on Geber and his writings, a list of manuscripts and printed editions of the Latin works, and many notes, together with a short glossary of alchemical terms. The book is illustrated with excellent reproductions of six plates from the 1541 edition, two from Libavius's Alchymia, 1606, and one other, of distillation, from a book published in 1512.

While Dr. Darmstädter's book is a noteworthy contribution to the voluminous literature on Geber, it cannot be said to have treated the matter comprehensively or altogether accurately. The questions of the identity of Geber and of the origin of his works " sind noch zu beantworten und sollen den Inhalt einer besonderen Arbeit bilden," but the author adopts uncritically the position of Berthelot and von Lippmann and dismisses, on entirely inadequate grounds, the possibility that " Geber " may be Jabir ibn Hayyan. The evidence on this point has recently been discussed in Nature (February 10, p. 191 and February 17, p. 219), but it may be well here again to emphasise that practically the only facts mentioned in the Latin works which have not so far been found in the Arabic works of Jabir ibn Hayyan are the preparation of *aqua regia*, *aqua fortis*, and silver nitrate. It is significant that even such an unimportant fact as the blue copper flame, noted by Geber (p. 66), is also described by Jabir ibn Hayyan (" Book of Properties," chap. 3), and, I believe, in no other work earlier than the thirteenth century.

The list of manuscripts is incomplete. Thus there is a fourteenth-century MS. of the " Summa " in the Bodleian, and another in Trinity College, Cambridge, while in the Hunterian Library at Glasgow there is one of the thirteenth century. Dr. Darmstädter knew of no MSS. of the " Liber fornacum "; there is, however, one which professes to be a translation by Roger Bacon, in the British Museum (*Sloane*, 1118, ff. 60-71). It is probably of the fifteenth century. At Gonville and Caius College there is a fifteenth-century MS. of the " Secreta Secretorum in opere solaris et lunaris," attributed to Geber; the title corresponds with that of a work by Jabir ibn Hayyan, the " Kitāb sirr al-Asrār." The Bodleian MS., " Ad laudem Socratis dixit Geber " (fifteenth century), calls to mind the work of Jabir entitled " Musahhihat Socrat," mentioned in the " Kitāb al-Fihrist," but now lost.

The translation is good and in general accurate, but it seems a pity that it was made from printed editions and not from early manuscripts, when it would have been much more authoritative. The notes are clear and scholarly; the information they contain is largely

derived from Prof. E. O. von Lippmann's "Entstehung und Ausbreitung der Alchemie." In view of the fact that copies of Geber's works are scarce, the present edition will be welcome to all chemists, for Geber had a pleasant style and his writings are full of interest and still worth reading. It is satisfactory, too, to see that the book is to be sold in England at what appears to be a very modest price.

It is perhaps fitting, in concluding this review, to ask the pertinent (but, it is to be hoped, not impertinent) question: "If Geber was not Jabir ibn Hayyan, who was he?"

E. J. HOLMYARD.

The Living Plant.

Botany of the Living Plant. By Prof. F. O. Bower. Second edition. Pp. xii+634. (London: Macmillan and Co., Ltd., 1923.) 25*s.* net.

THE publication of a second edition of Prof. F. O. Bower's excellent "Botany of the Living Plant" less than four years after the appearance of the original work shows that the volume has received the recognition it so justly deserved. This new edition has undergone a good deal of alteration, much of which has been made by the author as a result of criticisms and friendly suggestions.

The changes have certainly improved the book to a very considerable extent, the most important being the treatment of the Cryptogams and Gymnosperms, which occupy the second half of the work. Instead of these plants being arranged with the Coniferæ at the beginning and the fungi, bacteria, and algæ at the end, Prof. Bower now begins the second half with a very useful chapter on evolution, homoplasy, homology, and analogy. This new chapter serves to introduce the progressive series of plant forms the life histories of which are traced in evolutionary series from the simplest Thallophyta to the complex Gymnosperms in the chapters which follow.

The series of chapters, culminating in the ferns and conifers, is followed now quite logically by the chapters on "Alternation of Generations and the Land Habit" and on "Sex and Heredity," which, though they have very properly been transposed, come at the end of the book as formerly.

The appendix (A) on types of floral construction in Angiosperms then follows, and forms a useful introduction to the systematic study of plants; and appendix (B) on vegetable food-stuffs is followed by a carefully compiled index and glossary; these complete the volume as in the first edition.

Several minor alterations have been noticed in comparing the two editions, and they are all distinct improvements: in particular the new chapter on "The Living Cell" deserves special notice. This chapter is a very useful addition, since, in the first edition, the general physiological conditions of the plant cell were not treated so fully as is necessary for a proper understanding of that continuous living system of which the plant body consists.

In this new edition, after describing fully the cellular construction of plants, the structure of the several living units which compose the plant body follows naturally, and allows the succeeding chapters on the tissues of stem, leaf, and root, and on general physiology, to be fully appreciated.

Specialists in one branch of botany or another may perhaps feel that sufficient space has not been given to one or other aspect of botanical science, which now covers so wide a field; but, as Prof. Bower very justly says in his preface to the first edition, "No attempt has been made after encyclopedic writing," and we feel that it is well for the student who is to be introduced to the plant as a living organism that the author has confined himself so admirably to the object on which he embarked, and has succeeded in producing a book which is certainly the standard British work on general botany.

Our Bookshelf.

War: Its Nature, Cause, and Cure. By G. Lowes Dickinson. Pp. 155. (London: G. Allen and Unwin, Ltd., 1923.) 4*s.* 6*d.* net.

WITH his usual convincing sincerity, Mr. Dickinson sets out the unanswerable case against war. He appeals especially to younger men to realise what the nations have done, what they are doing now, and what it must all lead to unless the issue is honestly faced, and every one makes up his own mind clearly as to whether he wants war or not. For readers of NATURE as such, the book would therefore have no immediate interest were it not that the author brings into some emphasis the relations of science and men of science to warfare.

If mankind does not end war, war will end mankind. If this has not been true in the past, it is true now because modern war is linked with modern science, which, if the chief hope for the world, is also its chief menace. Men of science have in consequence more than average weight in deciding whether war is to continue or not; and some at any rate of them will not fail to be moved by Mr. Dickinson's appeal to bring all the prestige and intelligence of natural knowledge on to the side of those who mean to end war. He suggests that chemists and physicists and others who might be concerned should collectively and internationally announce that they did not propose to communicate to governments anything which would be useful in war—an impossible proposition, as the author would know if he had more acquaintance with the history and mode of progress of scientific

knowledge and with the ingenuity with which men who are determined to kill will degrade every scrap of human information to their end. But it is no impossible chimera that men of science should refuse to help in applying their special knowledge to the prosecution of war, and should let it be known that if war is to continue it must be waged without their assistance. Mr. Dickinson, at any rate, will be satisfied if they will read his book, reflect honestly and plainly on the implications of what he has to say, and bring to their conclusions the same independence and clarity that they apply to their daily work. It is difficult to believe that there will be many who after doing this will still be on the side of war. A. E. B.

British Museum (Natural History). Guide to the Exhibition Galleries of Geology and Palæontology. Pp. 64. (London: British Museum (Natural History), 1923.) 1*s*.

THE Keeper of Geology, in his preface to this small book, says, "It is merely a guide, not an introduction to the study of fossils." Those familiar with official scientific publications may appreciate the modesty and wisdom of this statement. But intelligent members of the general public, for whom the book has been written, will soon find that the statement errs on the side of diffidence; they will say, "This is not merely a guide, but a remarkably good guide"; and, taking it with them round the galleries, may discover to their advantage that it is one of the best short introductions to the study of fossils in the English language.

The casual visitor to these magnificent geological collections is often bewildered by the multitude of objects and oppressed by the strangeness of nomenclature. With this guide he will be led in an orderly and logical manner through the whole series of exhibits, his attention being directed only to outstanding features of each group; the systematic names are explained in everyday terms and the essential characters of the fossils are made clear, while no opportunity is lost of showing how the forms of these extinct creatures throw light upon their habits and phylogeny. Thus a great deal of sound information is woven into a readable story, which does not neglect human interest but links up the fossils with their discoverers or with some apt reference to literature or history. Who will not be tempted after reading of Thomas Hawkins to look up his descriptions of the hunt for Ichthyosauri, or to renew an acquaintance with "The Chambered Nautilus" of Oliver Wendell Holmes?

Dr. F. A. Bather, the author, has rendered good service to palæontology and to the public at a time when there was never more need for a straightforward introduction to this valuable and fascinating branch of knowledge, understandable by the ordinary man. J. A. H.

The Microscope: A Practical Hand-book. By L. Wright. Enlarged and rewritten by Dr. A. H. Drew. Pp. 287. (London: Religious Tract Society, n.d.) 5*s*. net.

IN the earlier chapters of this book an excellent account is given of the fundamental principles of optics, the practical optics of the microscope, and of the simple and compound microscopes. The salient features of a number of microscope stands by various makers are detailed and many of the instruments figured. Accessories, dark ground illumination, and methods for testing objectives are also described, together with manipulation and photo-micrography. Separate chapters are then devoted to the various objects of microscopy, such as pond and insect life, animal and vegetable histology, and others, with directions for manipulating and mounting them. The sections on staining have been revised and brought up-to-date and new stains and methods introduced. Thus, directions are given for the demonstration of mitochondria, the Golgi apparatus, karyokinesis, etc. The book contains a mass of accurate information, is profusely illustrated, and can be cordially recommended, not only to the beginner, but also to many who have already passed the elementary stage.

Organic Chemistry: or, Chemistry of the Carbon Compounds. By Victor von Richter. Edited by Prof. R. Anschütz and Dr. H. Meerwein. Vol. 3: Heterocyclic Compounds. Translated from the Eleventh German edition by Dr. E. E. Fournier d'Albe. Pp. xviii+326. (London: Kegan Paul and Co., Ltd.; Philadelphia: P. Blakiston's Son and Co., 1923.) 25*s*. net.

THE present volume, like the two preceding ones, is a useful guide to organic chemistry for general laboratory use, but it suffers from the same defect in being out-of-date. Heterocyclic derivatives of phosphorus and arsenic, for example, do not appear in the index, nor, apparently, in the text. References to English work are given to the German *Centralblatt*, without the names of the authors, and one gathers the entirely incorrect impression that organic chemical work is confined almost exclusively to Germany. The nomenclature is not always that adopted in England; the quinoline nucleus is numbered according to a system which has not been in use in this country for many years. The best method of preparation of a substance is not specially indicated, and not enough distinction is made between methods of *preparation* and methods of *formation*. Until English chemists supply their own needs, however, such books will have to be used.

Atoms. By Prof. Jean Perrin. Authorised translation by D. Ll. Hammick. Second English edition revised. Pp. xv+231. (London, Bombay and Sydney: Constable and Co., Ltd., 1923.) 8*s*. 6*d*. net.

THE second English edition of Prof. Perrin's inimitable book has been carefully revised in accordance with the eleventh French edition, and a certain amount of new matter added for the first time. The latter covers, for example, Perrin's new theory of radiation and chemical change, and there is a complete list of isotopes at the end of the book. Of the original work it is scarcely necessary to say anything: it has become a scientific classic, and is at the same time an account of the latest views on the subject. The translation has been well done, and the meaning is clearly rendered. In one or two cases (*e.g.* p. 112) "ou bien" has been translated "better," which is not its meaning in the examples cited.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Crossed-Orbit Model of Helium.

THE spectrum formula

$$\nu = \mathrm{N}\left[3 - \frac{7}{4\pi}\mathrm{F}\left(\sin\frac{i}{2}\right)\right], \quad . \quad . \quad . \quad (a)$$

proposed for helium in my letter of March 1 (NATURE of April 28, p. 567), was shown to yield, for $-\cos i = \frac{1}{2}$, the correct ionisation potential and, for $\frac{4}{5}$, $\frac{2}{3}$, $\frac{3}{5}$, $\frac{5}{9}$, the four Lyman lines; with that corresponding to the former as the limit. The deduction of this formula (on lines by no means classical) and the attitude to be taken with regard to the "negative" results obtained in the meantime by Dr. Kramers by means of classical mechanics (*Zeits. f. Physik*, 13, 312) have been fully explained in a paper appearing in the June issue of the *Astrophys. Journal*, and need not be repeated here. The purpose of this letter is to point out some further peculiarities of the formula (a) as such, which will be seen to bring order into the apparently queer correlation given before.

If the simple rational values of $-\cos i$ are ordered in descending magnitude, namely,

$$\tfrac{4}{5}\ (\tfrac{3}{4})\ \tfrac{2}{3}\ (\tfrac{5}{8})\ \tfrac{3}{5}\ (\tfrac{4}{7})\ \tfrac{5}{9}, \quad . \quad . \quad . \quad (b)$$

every second, bracketed one, covers no observed line, while the others represent orderly the first four members, $m=1$, etc., of the Lyman series $o\mathrm{S} - m\mathrm{P}$. Extrapolating the regular sequence of the last three fractions by

$$(\tfrac{6}{11}) \text{ and } \tfrac{7}{13},$$

one would expect the former to cover no line and the latter to represent the line $o\mathrm{S} - 5\mathrm{P}$, which, though hitherto not observed, can be expected with confidence. Now, with Lyman's oS and the usual 5P, this line should lie at $\lambda_5 = 512{\cdot}1$, while formula (a) gives, for $\cos i = -7/13$, $\lambda = 512{\cdot}3$. Again, turning to the left-hand end of the sequence (b), the next fraction $\frac{5}{6}$ naturally suggested itself as worth trying. For this value of $-\cos i$ ($i/2 = 73{\cdot}221°$, $\mathrm{F} = 2{\cdot}6642$) formula (a) gives $\lambda = 601{\cdot}2$, which is very close indeed to the "single line at $600{\cdot}5 \pm 0{\cdot}3$," repeatedly obtained by Lyman. As I understand from Prof. Lyman himself, he feels reasonably certain that it is genuine and that it belongs to the spectrum of helium. Moreover, from the semi-empirical point of view, the "combination" line $o\mathrm{S} - 1\mathrm{S} = 198{,}300 - 32{,}033$ would lie at $\lambda = 601{\cdot}3$, which is still closer to our result.

Thus, gathering the scattered items, we have, as an extension of (b), the following correlation (in which the bracketed numbers cover no observed lines):

$$\begin{array}{c|cccccccccccc} \tfrac{5}{6} & \tfrac{4}{5} & (\tfrac{3}{4}) & \tfrac{2}{3} & (\tfrac{5}{8}) & \tfrac{3}{5} & (\tfrac{4}{7}) & \tfrac{5}{9} & (\tfrac{6}{11}) & \tfrac{7}{13} & \ldots & \tfrac{1}{2}. \\ o\mathrm{S}-1\mathrm{S} & \lambda_1 & & \lambda_2 & & \lambda_3 & & \lambda_4 & & \lambda_5 & & \lambda_\infty \end{array} \quad . \quad (c)$$

Notice that, according to Prof. Lyman, the arc spectrum of He contains no lines in addition to those here covered. The regular intermittency of (c), so far as the members $o\mathrm{S} - m\mathrm{P}$ are concerned, is manifest. The position of $o\mathrm{S} - 1\mathrm{S}$—the "queer" line, as Dr. Compton of Princeton called it—is correspondingly queer. Yet even this, though only a combination line, fits into the further remarkable regularity of the whole sequence (c), to wit, that the differences between the successive fractions are all of the form $1/np$, thus $5{\cdot}5 - 4{\cdot}6 = 1$, $4{\cdot}4 - 3{\cdot}5 = 1$, $3{\cdot}3 - 4{\cdot}2 = 1$, and so on. This curious feature was first noticed by my friend Prof. A. S. Eve of Montreal only after the whole array (c) was spread over the black-board in a recent lecture at the Bureau of Standards. It may thus be said to have grown out spontaneously, and certainly did not influence the writer in constructing the proposed formula.

So long as intra-atomic dynamics is awaiting its final shaping from modern groping attempts at a suitable modification of ordinary mechanics, every such regularity of correlation, no matter how "magical" in appearance, seems worthy of noticing, as a possibly helpful hint how to alter the old laws for intra-atomic purposes. LUDWIK SILBERSTEIN.

129 Seneca Parkway,
Rochester, N.Y., May 15.

Symmetry of Calcium Thiosulphate Hexahydrate.

CALCIUM thiosulphate hexahydrate, $CaS_2O_3 \cdot 6H_2O$, is usually quoted in works on crystallography as an example of the triclinic asymmetric class, C_1^1—perhaps as the only known crystal which definitely represents this type of structure. It is described in Tutton's "Crystallography" (new edition, p. 280, old edition, p. 285), and, in more detail, in Groth's "Chemische Krystallographie," vol. 2, p. 676. In the latter we read

$CaS_2O_3 \cdot 6H_2O$. Asymmetric. Sp. gr. 1·872.

$$a : b : c = 0{\cdot}7828 : 1 : 1{\cdot}5170.$$

$$\alpha = 72°\ 30', \quad \beta = 98°\ 34', \quad \gamma = 92°\ 45\tfrac{3}{4}'.$$

The process by which symmetrical crystals are built up from less symmetrical material has been recently described by Sir William Bragg ("The Significance of Crystal Structure," Trans. Chem. Soc., 1922, vol. 121) and G. Shearer ("The Relation between Molecular and Crystal Symmetry as shown by X-ray Crystal Analysis," Proc. Phys. Soc., February, 1923). In the latter paper the author suggests that Nature never uses more molecules than are absolutely necessary for the purpose; that is, no more than N asymmetrical molecules will be used in the construction of a crystal of "symmetry-number" N, or, if the symmetry of the molecules be that of some class n, then no more than N/n will be used. Up to the present this hypothesis seems to be justified. In all organic crystals that have been examined in Sir William Bragg's laboratory not one has yet been found to contradict it. In all cases there has been no evidence to show that polymers of chemical molecules have been used, but, on the contrary, abundant evidence to show that the ultimate structural bodies correspond to the simple chemical molecules. Furthermore, it has been shown that, in general, the symmetry of a crystal is of a higher type than that of the molecules from which it is built—a rule which seems to be almost universally true. Especially with complex molecules does Nature resort to the device of combining a molecule with its digonal or its enantiomorph before using them to construct a Bravais lattice.

In view of these considerations it seemed very probable that, should a truly asymmetric crystal be obtained, its space-lattice would be found to be constructed of asymmetric groups of atoms corresponding to single chemical molecules; that is, it would be found to contain only one molecule per fundamental cell. Such a case seemed to be presented by $CaS_2O_3 \cdot 6H_2O$, and, indeed, it was expected that X-rays would show it to be a simple triclinic lattice of single asymmetrical molecules, obeying, of course, the law of rational indices, but exhibiting no symmetry operation beyond that of identity.

By means of the Bragg ionisation spectrometer an examination of this crystal has been carried out. The results are in full agreement with a *two-molecule* cell (Table I.).

TABLE I.

Plane.	Spacing.		Approx. Intensities (Height of Peak).			
	Calc. on 2 per Cell.	Obs.	I.	II.	III.	IV.
001	10·66	10·66	32	40	21	17
011	6·93	6·84	15	23	22	2
012	5·04	5·04	11	23	3	..
010	7·09	7·04	46	24	22	..
$0\bar{1}1$	5·23	5·21	8	110	2	1
$0\bar{1}2$	3·76	3·77	63	45	4	..
$0\bar{2}1$	3·10	3·10	1	10	..	..
$0\bar{1}3$	2·86	2·86	90	7	..	..
100	5·76	5·76	18	47	1	2
101	4·79	4·80	0	7	13	7
201	2·69	2·66	11	5	..	..
301	1·84	1·84	8	0	..	..
$1\bar{1}0$	4·48	4·48	32	5	4	..
$1\bar{2}0$	3·03	3·03	18	17	2	..
$1\bar{3}0$	2·19	2·18	11	4	..	..
$2\bar{1}0$	2·67	2·67	31	2	0	..
110	4·46	4·46	0	70	5	0
210	2·66	2·66	7	14	..	..
111	4·23	4·23	96	18	13	..
211	2·57	2·57	9	2	..	..
$1\bar{1}\bar{2}$	4·08	4·08	70	9	2	..
$1\bar{1}\bar{1}$	4·65	4·65	55	45	15	..

Of course, we might now argue that this does not prove anything, since the theory of space-groups takes no cognisance of the structure of the ultimate asymmetric units, but confines itself to the number and relative orientations of these necessary to produce one or other of the 230 homogeneous point-systems. Theoretically, it is just as easy to conceive of a crystal of the class C_1^1 being built from a two-molecule cell as from a one-molecule cell. In the former case it would simply mean that to construct an asymmetric lattice, Nature, at variance with her usual procedure, had used an asymmetric polymer of the chemical molecule instead of the single molecule.

In spite of this, it is here suggested that $CaS_2O_3 . 6H_2O$ is *not*, after all, the unique example of the triclinic asymmetric class, but only one of the many examples of the pinakoidal class C_i^1. The following reasons are given for this: (1) in all complex crystals so far examined, the ultimate structural unit has proved to correspond to the chemical molecule; and (2) there is a mass of evidence to show that the crystal symmetry, as deduced from a study of facial development and etched figures, is often of a lower type than the true structural symmetry as deduced from X-ray data (and generally confirmed by other indications). An interesting paper dealing with this subject has recently been contributed by E. T. Wherry, *Am. Journ. Science*, September 1922; but as a few well-known examples of this pseudo-symmetry we may cite potassium chloride (cubic holohedral, *not* pentagonal icositetrahedral), diamond (cubic holohedral, not hexakis-tetrahedral), cuprite (cubic holohedral, not pentagonal icositetrahedral), wulfenite (tetragonal holohedral, not pyramidal), and ammonium chloride (not pentagonal icositetrahedral, but either hexakis-tetrahedral or holohedral). The last-named is especially interesting since it has been examined by several workers. It now seems conclusive that its structure is what was originally suggested (Bragg, "X-rays and Crystal-Structure," p. 158), that it belongs not to an enantiomorphous class of the cubic system but to a class showing planes of symmetry (probably hexakis-tetrahedral—see R. W. G. Wyckoff, *Am. Journ. Science*, December 1922). With such crystals as these we must class many of the co-ordination-compounds of the type $\{Me'''(X_3'')\}R_3 . nH_2O$ examined by F. M. Jaeger ("Recherches sur le principe de Pasteur," *Rec. d. trav. chim. d. P. B.*, tome xxxviii.). Though substances of this type are very strongly optically active, many of their crystals appear to lack the characteristics of the enantiomorphous classes.

These few examples will suffice to show that it has become unsafe to argue from form development and etched figures, that, for example, the hitherto accepted evidence for placing $CaS_2O_3 . 6H_2O$ in the asymmetric class is not trustworthy. It is becoming increasingly clear that the boundary conditions of a crystal are often so different from the conditions obtaining inside the structure that not only the growth but also the inverse process of solution (etched figures) leads to a definite *under*-estimate (in most cases) of the real internal symmetry.

On the other hand, all the evidence so far is now in favour of placing $CaS_2O_3 . 6H_2O$ in the pinakoidal class, since the cell contains two molecules, and, by analogy with other known structures, these may be taken to be centro-symmetrical with respect to each other. It is true that this latter supposition cannot yet be proved, because in the triclinic system the two molecules, provided they are so orientated as to be centro-symmetrical with respect to each other, may occupy any relative positions in the cell. However, X-rays certainly show that the *smallest* cell which repeats through space contains two chemical molecules, and that there is no evidence that they are alike. The inference then is that they are the inversions of each other and that the complete structure is in reality centro-symmetrical. In this connexion it should be noted that two other triclinic crystals have also been thoroughly examined, namely, anhydrous racemic acid and racemic acid monohydrate. If only for chemical reasons, there is no doubt that these two crystals are built of molecules which are inverse to each other, and X-rays again show that the smallest cell which repeats through space contains *two* chemical molecules only.

If we knew more about the intensities of X-ray reflections, we should be able to prove that the two molecules in the cell of $CaS_2O_3 . 6H_2O$ are inverse to each other, but for the present this is impossible. For the same reason, no attempt has been made to fix the atomic positions in the cell. An examination of the optical properties would be highly desirable, with the view of detecting rotatory polarisation, should any be shown. Such a test would then be practically decisive.

For the preparation of the crystals which have been examined, I wish to express my indebtedness to Mr. C. P. Proctor, of the Chemical Laboratory, University of Birmingham.

W. T. ASTBURY.
Physics Department,
University College, London.

A Method of Photographing the Disintegration of Atoms and of Testing the Stability of Atoms by the Use of High-speed Alpha Particles.

WHILE the experimental work of Rutherford demonstrates the disintegration of the nuclei of the atoms of six elements of odd atomic number to give long-range hydrogen nuclei, it does not show whether shorter-range products of disintegration are emitted. It occurred to one of the writers several years ago

that the photographic method of C. T. R. Wilson would be the best means easily available of actually testing the stability of the nuclei of atoms for the different types of disintegration, particularly when the particles emitted have a short range. In the earlier applications of this method polonium has been used almost exclusively as the source of α-particles. The α-particles thus emitted have a relatively small kinetic energy, so the evidence obtained from the photographs is not of much value in its bearing on nuclear stability. The writers have therefore used the high-speed α-particles from thorium C′, with a velocity of $2 \cdot 05 \times 10^9$ cm./sec., or 0·688 c.

In an earlier letter (NATURE, January 27, p. 114) we gave a photograph showing the sharpest collision obtained in ten thousand exposures, the α-particle being turned through an angle of about 125°. The sharpest collision given by Blackett (Proc. Roy. Soc. A, 103, p. 79 (plate 3)) is less sharp, since the α-particle is turned through an angle of 110° or less. Fig. 1 shows two views, taken from directions perpendicular to each other, of a collision between an α-particle and the nucleus of an atom of air. This is the sharpest collision we have obtained by taking twenty-one thousand photographs. In this case the α-particle is turned through an angle of 165°, so that the lines which show the track of the α-particle before and after the collision exhibit a sharp angle equal to 15°.

In an ordinary collision the initial track of the α-particle splits into two branches beyond the point where the collision takes place. One of these is due to the rebounding α-particle, and the other to the forward track of the nucleus which is hit. If this nucleus were to disintegrate during the collision or quickly enough afterward, an additional track would emerge from the point of collision, and this would be due to the fragment, such as a hydrogen nucleus or an α-particle, which is ejected. It is possible, too, that electrons or other additional particles might

FIG. 1.—α-ray track which splits into three branches after a collision. The upward loop in the initial track is due to the diffusion of electrons out of a region partly robbed of water vapour by an earlier track.

also be emitted, so that the track might split into even more than three branches. However, all of the particles thrown off may not produce visible tracks. Thus the tracks given by high-speed electrons are faint, and are sometimes invisible in parts of the gas which have been robbed of their water vapour.

The extremely sharp collision photographed in Fig. 1 exhibits the very interesting phenomenon that the original track splits into *three branches at the point of collision, which is exactly the characteristic to be expected if the bombarded atom disintegrates*. The film on which the photograph was taken shows the lines at the point of collision much more plainly than the reproduction, and a study of the black lines on the film as seen under the microscope indicates that the third particle is shot diagonally upward, exactly from the point of collision as nearly as this can be determined by a microscopic examination of both of the views (taken at right angles). The great relative brightness of the track of this particle is due to the fact that the camera gets a "head-on" view. The discussion of the momentum relations will be left to a more complete paper, but it may be stated that, so far as we are able to determine, the collision does not exhibit conservation of momentum if the particle which shoots upward is left out of account. If this could be definitely proved it would give remarkably substantial evidence, in addition to that of the number of tracks, that a disintegration has occurred.

FIG. 2.—Nearly parallel curved tracks of particles ejected backward. Probably these are due to electrons.

Bumstead, and later Wilson, have secured photographs of the tracks of δ-rays, supposedly due to electrons pulled out of the non-nuclear systems of the atoms through which the α-particle passes. These tracks are extremely short, and are most easily seen when the expansion in the ionisation chamber is not too high. Fig. 2 shows an entirely new type of secondary track. Here what appear to be electrons are thrown out a great many times as far as in the δ-rays, and in a different direction. The two electron tracks curve upward, show a backward motion, and are remarkably close to being parallel. They differ so markedly from those of the δ-rays that they may be considered as a different type of ray. They may be designated as ζ-rays.

Altogether about eighty thousand tracks have been photographed. From the assumed dimensions of a molecule in air it may be estimated that each α-particle passes through between 100 and 200 thousand atoms, so approximately 10 billion atoms have been shot through, with the result that only three nuclear collisions have resulted in which the initial α-particle has been given a *retrograde* motion. In only one of these, as illustrated in Fig. 1, has the collision been very direct. The photographs show many other interesting relations which cannot be discussed here.

WILLIAM D. HARKINS.
R. W. RYAN.

Science and Economics.

MAY I bring this correspondence back to earth by recalling that I based my deduction that no one even pretended to understand the present economic system upon the fact that, although the age is as far ahead of any preceding epoch in the science of producing wealth as it is in astronomy or chemistry, yet millions of

folk are (1) without decent means of subsistence, (2) idle? My impression, in directing the attention of scientific men to this problem, was that a very little of the original thought which they habitually devote to more abstract questions would give the solution of this one. But I scarcely bargained for NATURE being so widely read as to render it necessary for me to meet philosophical arguments.

Mr. Leisenring, who devotes four of your valuable columns to a defence and elucidation of the philosophy of the system challenged, looks characteristically for a change of ideals to bring about the readjustment which he admits to be most urgent. Now, what was there reprehensible about the ideals of the nineteenth century? Was it not the ideas which were upside down? I need not follow him in his fanciful descriptions of and deductions from my views, though, indeed, it is a novelty for readers of NATURE to be told that a proposal to ascertain the physical basis of economics is tantamount to an attempt to baulk human evolution and to impose upon man an inferior order of existence. Surely most of us thought that the ascertainment and understanding of the laws of Nature were preliminaries to governing and directing them to human ends. Eastern proverbs notwithstanding, the achievements of one age in this field are the starting-point of those in the next. Your correspondent seems to confuse the methods of science with those that apply to the government and direction of men at the hustings, on the battlefield, in the Courts and theatres, and by the general Press. Such confusion is widespread, and the results of scientific progress need to be safeguarded and made "fool-proof" from the interference of the humane genius.

However, I cordially agree, and have myself remarked, that the original great rulers of the world were under no such vulgar delusions as are current to-day about gold and money. Mr. H. O. Weller recently told me that Kublai Khan's currency was of *papier mâché*, and that some of his coinage is extant. The important point to them was not what the coin was made of, but whether they issued it. My description of the present financial system as counterfeit was in allusion to the fact that less than 1 per cent of the money functioning as such is authorised by the King and issued by the Royal Mint. Olden-time rulers issued the currency, but that also is "inverted." Since millions are (1) destitute, (2) idle, the presumption is that, although many may understand perfectly the art of making money, the reason which makes this, necessarily, a royal prerogative is now not understood by any one.

I am sorry if the laws of evolution preclude, and the annals of history do not record, an absolute innovation, and I cannot defend the word "absolute," since innovations are necessarily relative. But it will be in the memory of many that recently there was a war, and, before a shot had been fired, a moratorium terminated the old financial system. The public credit became necessary to maintain solvency. Though it would be rash to predict that in the future the old system may not be restored in a modified form, it does not appear imminent. On my analysis it is difficult to see how the public credit can be dispensed with. For what else is behind the colossal accumulation of indebtedness which we have inherited from the age of irreproachable ideals and inverted ideas? The honest intentions to meet "promises to pay," and the ability to perform what this industrial age and its ideals demand, were quietly transferred to the broader shoulders of the public during the hubbub preceding Armageddon. The rope has been lengthened and its end attached to a larger neck. The ultimate basis of credit has been widened, but from the point of view of physics it is still credulity.

The spontaneous increment of wealth is subject to the laws of thermodynamics, like all conversion of natural resources, whether to useful or useless forms. You may *measure* it, so long as it exists to measure, by the spontaneous increment of debt, and the philosophy of usury is much more interesting no doubt than thermodynamics, and is likely to counteract the unemployment engendered by the achievements of the latter science, even among those who, like your correspondent, find life tends to become uninteresting. So you can measure the horse-power of an engine by braking it, or the content of a pot, not only by filling it when empty but also by emptying it if it be full. For any other purpose than mere measurement, however, to try to fill a leaky pot, or to run an engine with brakes on, is foolish. So long as wealth production was not understood, the virtues of gold or usury or other magical influence could be invoked. But that time is past. Until Mr. Lane Fox Pitt came to the rescue with his euphemistic theory of psychological inversion (NATURE, May 19, p. 670), I found it difficult to discuss these matters without giving offence. I fear, however, that a system of economics based on a philosophy of usury imagines the process of emptying to be a reversible cyclic process—that the pot is emptied back into the clouds rather than into the ocean.

To come to the concrete, I have a method of producing, more economically than any other person, the goods that the community desire. Is that a collateral security? No: but if I have a block of receipts for the wealth blown up in the Napoleonic wars, known as Consols, or any other gilt-edged security, I can obtain the community's credit at any time, without the necessity of being able to produce anything at all. The process is almost too incredibly Gilbertian to discuss in NATURE. But clearly there is something very different in practice from primitive philosophic conceptions of credit, since the power to pledge the community's credit is vested, not with those with ability to produce but with those with ability to consume, though the powers of consumption may date back to some remote forerunner of the modern patriot in the Napoleonic era, and the goods consumed then may have already been paid for many times over.

The use of mechanical energy made possible an enormous, if finite, increase of the *revenue* of wealth. This annual *revenue*, by the simple process of dividing it by the rate of interest, say 0·05, is multiplied by twenty or "capitalised." The capital, however, differs from the earlier forms of credit, such as land or factories (that is, until they become obsolete and tumble down), in being non-existent, and this difference I submit is fundamental. It is also under the necessity of increasing according to an exponential law without limit, which is physically absurd.

FREDERICK SODDY.

[We regret to be unable to devote space to further correspondence on this subject.—EDITOR, NATURE.]

A Puzzle Paper Band.

PROF. C. V. BOYS's puzzle (NATURE, June 9, p. 774) is a deal less puzzling (as he doubtless knows) if we begin it at the other end. Instead of making the long belt with its two loops which he describes, and then trying to reduce it to the well-known half-twist "double surface" (cf. *e.g.* Forsyth's "Differential Geometry," p. 296) of double thickness, let us begin by laying two strips of paper one on the other;

then with a half-twist bring the ends together, and fasten the corresponding ends each to each. Our half-twist will have brought one end of the lower strip into contact with the other end of the upper strip; and what we then obtain, on opening out, is the long loop (or "worble," to use Maxwell's word) with its two curls, which Prof. Boys starts with. We have simply *split* into two sheets our original one-sided, one-edged surface, and obtained a new *bifacial* surface thereby, precisely as Mr. B. M. Sen explains in his recent paper on "Double Surfaces" in the Proc. Lond. Math. Soc.

We may vary the experiment by starting with three sheets (or with five) instead of two. The middle sheet or strip, joining on to itself, will always remain the half-twisted loop, the unifacial surface; while each adjacent pair of strips will constitute a bifacial surface such as Prof. Boys describes. The median loop will involve, or link together, all the others; but the manner in which these latter interlace with one another is more complicated. The problem of how to split an anchor-ring into two rings, interlinked with one another, is a simple corollary.

It is somewhat curious at first sight, but obvious after all, that we arrive at precisely the same result whether we split our sheet, or cut it longitudinally. Begin with one broad strip, joining its ends together into the half-twisted unifacial surface; then make one continuous longitudinal cut, not far from the edge. This single cut gives us two complete loops, one being the border and the other the median zone of our broad strip. The median band has its properties unaltered; it is still the half-twist unifacial surface, only narrower than before. The other, on which our scissors have bestowed a second edge, is the bifacial surface which Prof. Boys calls his "puzzle band."

D'ARCY W. THOMPSON.

44 South St., St. Andrews,
June 19.

Active Hydrogen by Electrolysis.

WENDT and Landauer (Jour. Amer. Chem. Soc., March, 1922, p. 513) failed to get any evidence for the presence of active hydrogen, generated by the action of an acid on a metal, or by the electrolysis of a solution of KOH. Similar results were also obtained by Y. Venkataramaiah (Proc. Sci. Assoc. Maharaja's College, Vizianagram, July 1921, p. 2). We have repeated the experiments, and find that hydrogen is actually activated when a conducting solution is electrolysed. We electrolysed a solution of dilute sulphuric acid, employing a platinum tube with a large number of pin-holes bored in it, and using a current varying from 3 to 15 amperes. While the electrolysis was going on, compressed nitrogen was bubbled through the solution, through the platinum electrode, to see if any ammonia were formed, as Wendt and Landauer found that active hydrogen combines with nitrogen to form ammonia. After a run of nearly twelve hours, the presence of ammonia was tested in the resulting solution. The result was positive.

Another method was also tried, using an iron tube as an electrode. It is known that nascent hydrogen diffuses through metals like iron even at ordinary temperatures. So it was found convenient to diffuse nascent hydrogen through the iron tube and test for the presence of active hydrogen by drawing it over cold powdered sulphur, the presence of hydrogen sulphide being tested for with a lead acetate paper. Here also a positive result was found.

The experiments with a metal and an acid are not yet successful. The failure in the case of the experiments of Wendt and Landauer, in our opinion, is due not only to the difficulties in removing the spray but also to the action of active hydrogen on the spray itself. Certain preliminary experiments conducted by us show that active hydrogen is decomposed by the spray with the formation of hydrogen peroxide.

It is a pleasure to note from the latest number of NATURE to hand (May 5, p. 600), that Prof. A. C. Grubb has succeeded by an ingenious experiment in demonstrating the presence of active hydrogen in the hydrogen generated by the action of hydrochloric acid on magnesium.

Y. VENKATARAMAIAH.
BH. S. V. RAGHAVA RAO.

Research Laboratories, Maharaja's College,
Vizianagram, S. India,
May 28.

The Transfinite Ordinals of the Second Class.

THERE is a theorem in the transfinite calculus that any ascending sequence of ordinal numbers of the second class has a limit which is also of the second class. This theorem is important, being wanted to prove that the aggregate of these ordinals is unenumerable.

Now consider the set of numbers $1, 2, 3, \omega, \omega+1, \omega+2, \omega.2, \omega.2+1, \omega^2, \omega^2+1$, etc. The mode of formation is that each number exceeds the preceding one by unity, except that if the plan we are following leads us to a limit we write down only a finite number of numbers according to that plan, and then write down the limit and the limit increased by unity, and so on. The set is normally ordered, and each element has an immediate predecessor, whence we easily see that it is a sequence. But it cannot have any limit in the second class, for if the limit is α the sequence must contain α and $\alpha+1$.

Does this contradiction with the first theorem show that the ordinals of the second class form an "inconsistent" aggregate? It differs from that of the Burali-Forti paradox in that we do not assume that our aggregate has an ordinal number before we get the contradiction. It agrees with it in that no contradiction arises if we consider segments only of the aggregate of ordinals.

H. C. POCKLINGTON.

5 Well Close Place, Leeds.

Shakespeare and the Indian Meteors of 1592.

WITH reference to Mr. Denning's remark in NATURE, June 23, p. 848, I beg leave to point out that the word in Persian for west, namely *khāwar*, also means east, and so it may be that the passage in the Akbarnama means that the meteors were travelling from east to west and not from west to east.

Dean Inge lately observed in a lecture that there was a mystery about what Shakespeare did in the last five years of his life. May it not be that he was travelling in Europe or on the high seas when he saw so many stars shoot madly from their spheres ("Midsummer-Night's Dream," Act II., Scene II.)? There is another allusion to meteors, "Yon fiery o's and eyes of light," in Act III., Scene II., where Lysander speaks of Helena's eyes. This seems to show that Shakespeare's mind was running upon stars and meteors.

I may mention that in a letter to me Sir Sydney Lee seemed to say that there was something in my suggestion, and referred to another topical allusion to natural phenomena in "Romeo and Juliet."

H. BEVERIDGE.

53 Campden House Road, London, W.8.

The Production of Single Metallic Crystals and some of their Properties.

By Prof. H. C. H. CARPENTER, F.R.S.

METALS and alloys are composed of aggregates of crystals. These do not, as a rule, possess plane faces, that is, the external forms of crystals. They

FIG. 1.—Showing diminishing size of crystals with increase of strain in the parallel portion of the testpieces. By permission of the Institute of Metals.

are joined together at boundaries which have been produced by the meeting of a number of crystals growing simultaneously, and are usually irregular in outline. It is generally assumed that on cooling, crystallisation starts in the liquid metal or alloy from a number of centres, and proceeds with a velocity and in a manner characteristic of the metal and the conditions under which it has been cooled. The resulting boundaries may approximate to plane surfaces, but are more usually curved and irregular. These crystals are called "allotriomorphic" to distinguish them from "idiomorphic" crystals, which do possess plane faces and are characteristic of most mineral substances and artificially prepared salts. Moreover, they are usually very small and cannot be distinguished without the aid of a microscope. It is true, that in the case of large castings weighing many tons, crystals of several cubic inches capacity have been formed and afterwards isolated. The great majority of metals and alloys, however, which have been cast and hot-worked, have from 150 to 300 crystals to the linear inch, corresponding to from 3,375,000 to 27,000,000 crystals in a cubic inch. Frequently the size is even smaller, especially in the case of steels. The crystals are still more minute in severely drawn wires, and from figures given by Sykes it appears that in molybdenum wire there may be as many as 5000 to the linear inch.

The properties of metals and alloys are the properties of these aggregates of minute crystals. Sauveur was the first investigator to show, about eleven years ago, that by carefully straining and afterwards heating metals, much larger crystals could be produced, and he suggested that there was a critical stress which produced the largest crystals. Later, other investigators, notably Rüder, Chappell, Jeffries, and Hanson, showed that if a metal was locally deformed and then heated, exceptionally large crystals were formed at some distance from the point at which the strain is most severe. About two years ago Miss Elam and the writer succeeded in converting the whole of the parallel portion of aluminium testpieces, whether in the form of sheets or bars, into a single crystal, which indeed extended for some distance up into the curved shoulders of the testpieces, forming an irregular boundary line. The crystals varied in volume from 0·5 to 2·0 cubic inches, and it has been possible to compare some of their properties with those of the aggregates of small crystals, of which this metal is usually composed. Experiments have also been carried out with iron, copper, silver, and tin, but with less success, although in all cases it has been possible to grow crystals very much larger than those contained in the original metal.

In the production of large crystals of aluminium the adjustment between mechanical strain and the temperature of heating is extremely important. This point is clearly brought out in Fig. 1, which shows how the crystal size may be varied in aluminium according to the degree of strain. The eight test-pieces shown, after a preliminary heat treatment to

remove work-hardness and render the crystals equiaxed, were subjected to degrees of tensile strain varying from two to ten per cent. extension on three inches of the parallel portion of the testpiece. After this they were all heated to 550° C. and kept thus for six hours. Finally, they were etched in a ten per cent. solution of sodium hydrate. It will be seen that the crystals in the testpiece extended two per cent. are very coarse, and that as the strain is increased the crystal size diminishes until at ten per cent. it has become quite small. But there is a further point to be noted, namely, that in all the eight cases shown, large crystals have also formed in the broad heads of the testpieces, where the strain must have been less.

The problem which we set ourselves was to convert the crystals, numbering about 1,687,000, in the parallel portion of a testpiece 4 in. × 1 in. × 0·125 in., into a single crystal. Three treatments, two thermal and one mechanical, are necessary. The testpiece in the original condition was cold-rolled, and as a result the crystals were very much elongated and worked into one another. It had first to be heated so that it might be completely softened and new equiaxed crystals of approximately uniform size produced. The most suitable temperature was found to be 550° C. and the time six hours. It had next to be strained to the required amount, which was equivalent to a tensile strain of 2·4 tons per square inch. Finally, it had to be heated so that the potentiality of growth conferred by strain could be brought fully into operation. This was a somewhat lengthy operation, and involved a heat treatment beginning at 450° C. and finishing at 600° C. over a period of about 100 hours. After these treatments, on an average about one testpiece in four is converted into a single crystal over the parallel portion. Sometimes this space is occupied by two, three, or even four crystals, but never by more than that.

The production of these very large crystals has enabled us to determine the tensile properties of single crystals and compare them with those of the aggregates of minute crystals of which such bars are usually composed. In the latter case very uniform results are obtained, the ultimate stress varying from 4·5 to 4·7 tons per square inch, and the percentage extension on three inches being from 36 to 38. The values obtained in tests of specimens consisting of single crystals varied, however, from 2·80 to 4·08 tons per square inch, while the extension varied from 34 to 86 per cent. measured on three inches. These variations in properties were accompanied by differences in the method of stretching and the types of fracture which have provided a means of classifying them.

Speaking broadly, five types may be distinguished. In certain cases the testpieces narrowed in breadth gradually from the shoulders towards the fracture, and the metal necked sometimes almost to a point. In other cases the testpiece remained broad, losing sometimes only one per cent. in breadth, but became very thin. In the third case the testpiece both narrowed and thinned uniformly, and a noticeable feature of this type is the sloping of the sides, so that the section after pulling is no longer a right-angled parallelogram but one with acute and obtuse angles. Slip bands were usually well marked, and were inclined to the axis at different angles. In the fourth type the testpieces not only narrowed and thinned but in addition necked at the fracture, and in all cases a sideways slip was evident. In the fifth type may be included all the testpieces which produced twin crystals on being pulled. No signs of these were visible before stress was applied. In some cases only a few twins resulted, while in others the testpiece was twinned all over. In every case the testpiece buckled and crumpled to a certain extent, owing to the shifting of portions of the sheet into a twinning position. These differences in the method of distortion and fracture are due to differences in the original orientation of the crystal in the testpiece.

Monocrystalline testpieces were also prepared in round bars of diameter 0·564 and 0·798 of an inch

FIG. 2.—Fractured testpieces of single crystals in round bars, showing how in each case the bar draws down in one dimension and produces a wedge-shaped (double-grooved) fracture. By permission of the Institute of Metals.

respectively. The deformation of these testpieces under tensile stress was very remarkable, and deserves special mention. On one hand, a bar consisting of the usual aggregate of small crystals drew down with a roughening of the surface, the maintenance of a circular cross section, and a cup-and-cone fracture. On the other hand, the single crystals flattened very much in one dimension, whereas the other dimension differed but little from the original diameter of the bar, and the end result was not a cup-and-cone fracture but a double groove. The bar when subjected to tensile stress slipped principally on one plane, which subsequent investigations by Mr. G. I. Taylor and Miss C. F. Elam have shown to be an octahedral plane. When it began to break it drew down sharply in the same direction in which it had thinned, and a lens-shaped area was formed. As the bar pulled apart this became flatter and flatter; it parted first at each side and then in the middle. The final result was a curious double-grooved fracture with flow lines. Fig. 2 shows the fractured testpieces of five single

crystals in round bars. In each case the two fractured halves are shown, one placed with the broad and the other with the narrow side facing the camera.

A word must be said about the crystallography of aluminium. Hull was the first to investigate the structure of aluminium crystals in a finely crystalline aggregate by X-ray analysis, and he concluded that the pattern thus obtained corresponds to a face-centred cubic lattice, *i.e.* the grouping of the atoms is such that there is one at each corner of the cube, and one in the centre of each face, making a total of fourteen in all. This corresponds, as Colonel Belaiew has recently pointed out, to an octahedron situated within a cube. Sir William Bragg and Dr. Müller have kindly examined our single crystals, and find that they conform to the same pattern. They belong, therefore, to the cubic system, and must have properties consistent with those of that group which possesses the highest degree of symmetry both external and internal. Investigations of the crystals in this system indicate that as regards certain properties they are isotropic, while as regards others they are anisotropic. In the former category come the properties of conducting light, heat, electricity, and expansion. In the latter are grouped elasticity, cohesion, and conduction of sound. In such cases, however, the properties are closely related to the symmetry, since the maximum and minimum values have been found to coincide with the axes of symmetry.

Accordingly, the variations in the tensile properties of the testpieces which have been described are due to differences of cohesion in different planes which do not all contain the same number of atoms. Although the single crystals obtained in the sheet and bars were formed in the same shaped testpieces in both categories, it was obvious that their original orientation relative to the axis of the testpiece varied considerably. Indeed, it may not have been precisely the same in any two of the cases tested. The shape of the testpiece alters when stress is applied, since slip and deformation take place only on certain planes, and the changes in shape observed correspond to the attempt of the crystal to accommodate itself to the stress. Such changes were much greater in some tests than in others.

It is not possible within the limits of this article to discuss the two questions, (1) why abnormally large crystals form on heating after a small deformation, and gradually decrease in size as the deformation increases; and (2), to take the extreme case, why, after a particular degree of deformation, it is possible to form a single crystal from an aggregate of several millions. Those interested in the matter may be referred to the author's original publications with Miss Elam.[1] It may, however, be stated that the conditions for the production of a single crystal in a testpiece consisting of the usual aggregate of small crystals are considered by us to be, that every crystal in the complex must be strained a certain amount, and that one of them is strained rather more than the rest. This particular crystal may be regarded as being in the condition of critical strain, and ultimately all the other crystals align themselves upon it after sufficient heating. When this condition is realised, the testpiece consists of a single crystal. We have taken up the experimental investigation of the deformation of the testpiece by X-ray analysis, and are hoping that the result of this will show what it is that happens when a testpiece is strained to the critical amount and subsequently heated.

[1] Journal of the Institute of Metals, No. 2, 1920, pp. 85-131. Proceedings of the Royal Society, V. 100a, pp. 329-353. Journal of the Iron and Steel Institute, No. 1, 1923.

The Royal Asiatic Society.

By F. E. PARGITER.

THE Royal Asiatic Society of Great Britain and Ireland was founded in London on March 15, 1823, by the distinguished Sanskrit scholar, Henry Thomas Colebrooke, supported by others interested in Oriental matters, to investigate (as he announced) the history, civil polity, institutions, customs, languages, literature, and science, ancient and modern, of all countries in Asia. This removed the reproach that, while similar societies had been formed at Calcutta, Bombay, Madras, Paris, and elsewhere, Great Britain had done nothing. The charter was granted on August 11, 1824, and under it the Society is governed by a council of twenty-five members, including the president, director, vice-presidents, and other officers, elected annually at general meetings.

The Society was well supported by the East India Company and many eminent men, and prospered and developed its activities. It appointed a "Committee of Correspondence," which embarked on far-spread measures to receive and communicate information about Asiatic matters. From the copious donations that it received it began a library and a museum. To utilise the Oriental MSS. collected in English libraries it established the "Oriental Translation Committee and Fund" in 1828, to publish translations of approved works in Oriental languages, and this was liberally supported, and published thirty volumes in the next four years. The scheme included measures to benefit Asia and Europe materially; hence, when trade with India and China was thrown open in 1833–34, the Society formed a "Committee of Agriculture and Commerce" in 1836, and this collected valuable information about coffee, sugar, opium, and other important commercial products and their improvement. The Society published three quarto volumes of "Transactions," containing papers read before it, in 1827, 1830, and 1833, and began an annual "Journal" in 8vo form in 1834.

The early enthusiasm, however, gradually declined; the membership fell and the financial position caused anxiety. Then came the time of the Cuneiform discoveries by Major (afterwards Sir) Henry Rawlinson, who found the great Behistun and other inscriptions in Persia, eclipsing those reported by earlier travellers. He communicated them to the Society in 1838, solved the problem of their decipherment in 1844, and announced his results in 1846. These were received by the public with much incredulity, but the Society

gave him its cordial support and set apart certain volumes of the Journal for their publication. Opinion turned after a time, and the Society became the centre of a great literary movement. His work, however, never reached completion in those volumes, because excavations by Botta, Layard, and others at Nineveh and Babylon brought out overwhelming material; new duties trenched on his time, and other scholars finished what he had so well begun.

Notwithstanding the interest of these revelations, the Society's condition remained anxious, for local societies in the East appropriated much local inquiry; its efforts to aid commerce became exhausted, and it developed more towards learned research, while Oriental studies attracted little public interest. The committees of correspondence, of Oriental translation, and of agriculture and commerce gradually fell into neglect, and a later effort to revive them had but transient success. The East India Company had generously subsidised the Society, and the loss of its patronage on its abolition in 1858 caused discouragement. The Government after some vacillation continued the subsidy, yet the Society's fortunes still continued low. It changed its abode in 1869, and through want of room made over its museum to the India Office.

The tide turned, however, when Mr. Vaux became secretary in 1877 and devoted himself to the Society's welfare, and more interest in Oriental studies began to be manifested then among the educated. The late Prof. Rhys Davids became secretary from 1887 to 1905 and edited the Journal, and enhanced the improvement. The Society's course since then has been one of steady expansion and influence, and its Journal has risen to acknowledged excellence with a wide and attractive range of subjects. The membership consists of those "resident" within fifty miles from Charing Cross and "non-residents," and also thirty honorary members elected from among eminent foreign scholars.

To reward British erudition the "Gold Medal Fund" was inaugurated in memory of Queen Victoria's Jubilee, and the medal was awarded in 1897 to Prof. Cowell, and since then triennially. Two other funds were established in 1903, the "Public Schools' Gold Medal Fund" and the "Prize Publications Fund." Under the former a prize medal has been awarded yearly on an essay on some Oriental subject in competition among the boys of the public schools. A new "Oriental Translation Fund" was started privately in 1891 and transferred to the Society afterwards, and it began a "Monograph Fund" in 1902. By these three funds many treatises have been issued, and the proceeds of the sale of published books provide the means of printing fresh works. Thus the Society encourages Oriental research, honours Oriental learning, and makes the results public, free of expense to the authors. Another fund, the Forlong Fund, is managed by the Society for the benefit of students at the School of Oriental Languages.

The Society is now established at 74 Grosvenor Street, London, W., and completed its hundredth year on March 15 last. It has issued a centenary volume, displaying its history and the achievements of its members in research, and will celebrate the event by a reunion of Orientalists and festivities on July 17-20. It has a very large and comprehensive library of about 30,000 volumes, important collections of MSS. in many Oriental languages, portraits and busts of eminent members, and valuable objects of antiquity and art. Its most outstanding figures have been its three directors, H. T. Colebrooke (1823–37), Prof. H. H. Wilson (1837–60), and Sir H. Rawlinson (1862–95), and its late president, Lord Reay (1893–1921).

The Journal abounds with articles elucidating all the subjects mentioned in the inaugural discourse regarding all the countries of Asia and those in Africa into which Mohammedanism overflowed, and India has occupied as much attention as all the other countries combined. Archæology has been a leading subject, especially since exploration has brought ancient inscriptions and other material to light from Asia Minor to Further India, and the old texts have become available for study. The Society's representations have largely contributed to archæological enterprise in India. Ancient remains have been examined, inscriptions deciphered, coins read, language and literature investigated, and religion studied. The researches have been so varied, that it is impossible to speak of them here except in general terms. They have not only amplified what was known of the ancient world, but have also reconstructed kingdoms and history that had vanished, disclosed much of the course of civilisation and religion through Asia, and revealed unknown languages that have perished.

Obituary.

Prof. John Chiene.

JOHN CHIENE, late professor of surgery in the University of Edinburgh, to which chair he had succeeded on the death of James Spence in 1882, and held for twenty-eight years, died on May 29 at the age of eighty. Chiene does not claim a record in this journal on account of original scientific work—for scientific inquiry was not much in his line—but he was deeply impressed with the importance of it, and, though not himself an experimenter, he set up in the University the first teaching laboratory of bacteriology and surgical pathology in the United Kingdom. To quote the words of his pupil Sir Harold Stiles, who now occupies the chair once held by Syme and Lister, "Chiene set the example, in the academic teaching of surgery, of cultivating the subject as a science so that its art might be better taught and promoted. . . . He spared neither time nor money to encourage research by his assistants."

Chiene may be said to have belonged to the school of anatomical surgeons; but he had been Syme's house-surgeon and John Goodsir's demonstrator, and from both of these distinguished men he inherited the habit of scientific thought and logical expression. He was a very successful lecturer on operative and systematic surgery in the extra-mural school, and in this way

prepared himself for his still greater success as a university professor.

When Lister came back to Edinburgh from Glasgow in 1869, the feud between the followers of Syme and those of Simpson was simmering out, but by no means forgotten. At that time John Chiene and John Duncan were the most prominent younger surgeons in that city. Both were among Lister's adherents, but Chiene was more than a mere adherent; he became at once a devoted disciple. Every day found him working and studying in Lister's wards, and as years went on he was more and more closely associated with Lister's work.

During his nine years' stay in Edinburgh, Lister was acquiring a world-wide reputation; but among his colleagues he met with sharp criticism from his opponents and only lukewarm support from his friends. Even Annandale, his successor in the chair of clinical surgery, though professedly a convert to the antiseptic doctrine, was not altogether successful in practising it. It was, therefore, most important when Lister went to London in 1878 that some trusty follower should remain in Edinburgh to keep the torch burning there, as Sir Hector Cameron was manfully doing in Glasgow. That trusty follower was found in Chiene. He was now in a very influential position, and he advocated the cause of antiseptic surgery by example and precept with great success until the younger men, Lister's pupils and his own—now themselves middle-aged—had succeeded to the various University chairs and hospital appointments; by which time Lister's principles, though not the details of his practice, had come to be recognised as orthodox and universally followed.

Edinburgh would, of course, like the rest of the world, have become fully enlightened in due time, but it can scarcely be doubted that the period of twilight would have been more prolonged if it had not been for Chiene's whole-hearted and persevering efforts.

Dr. W. d'E. Emery.

By the death of Dr. Walter d'Este Emery on June 19, pathology has lost a keen disciple, and his acquaintances a loyal friend. Emery was a distinguished student of Queen's University, Birmingham, and St. Bartholomew's Hospital, London. After junior appointments held at his schools, he became assistant bacteriologist to the Laboratories of the Royal Colleges of Physicians and Surgeons. Later, he was lecturer on pathology and bacteriology in the University of Birmingham and Hunterian professor at the Royal College of Surgeons. Coming to London, he held various appointments, finally being made lecturer on pathology and bacteriology, and director of the Laboratories, King's College Hospital, a post he had to relinquish some two years ago on account of ill-health.

Emery was the author of "Clinical Pathology and Hæmatology," which passed through several editions and contains many practical hints, the outcome of his wide experience, and of "Immunity and Specific Therapy," which at the time of publication in 1909 presented an excellent critical survey of the extensive literature on these subjects. He was keenly interested in the problem of cancer, and a supporter of the parasitic hypothesis of the causation of this malady, arguments in favour of which are clearly set forth in another small book, "The Formation of Tumours." He published papers on the opsonic index and Wassermann reaction, and devised a simple method of complement fixation for the diagnosis of tuberculosis. He also contributed articles to Cheyne and Burghard's "Surgical Treatment," and Rose and Carless's "Surgery."

Emery was a bacteriologist and serologist of the first rank, and in later days a competent morbid histologist. Throughout his career he was overburdened with routine work; with more opportunity, it can scarcely be doubted his output of research work would have been larger. R. T. H.

Miss A. C. Breton.

We regret to record the death on June 15, at Barbados, of Miss Adela C. Breton at the age of seventy-three.

For more than thirty years Miss Breton travelled extensively and studied in many parts of the world, and her ready pen and keen powers of observation made her letters a delight to her friends. She had considerable talent as an artist, and utilised this gift to advantage in the pursuit of her archæological investigations. In Japan, for example, she made a very thorough study of the temples in a series of large water-colour drawings. Her name, however, will best be remembered in connexion with her expeditions to Mexico—which she visited thirteen times—and other parts of Central America, for the purpose of studying the antiquities of that region. In her travels in Mexico in the early 'nineties she rode on horseback, accompanied by one Indian only, a feat which in those days required both courage and much power of endurance. At the suggestion of Mr. A. P. Maudslay, she undertook to copy in water-colour the mural paintings of Chichen Itza in Yucatan, and produced a remarkable series of records of great beauty and high scientific value, unfortunately still unpublished. Miss Breton was also responsible for the copy of the pre-Columbian map of Mexico City, preserved in the National Museum of Mexico, and of the map of the Valley of Mexico, by Alonzo de Santa Cruz, in the University of Uppsala, which were published in Mr. Maudslay's translation of the "Conquest of Spain," by Bernal Diaz de Castillo. Of the former, Mr. Maudslay says it "needed long familiarity with Mexican picture-writing and topography to accomplish so successfully."

Miss Breton's great accuracy and industry served her and her readers well in the many papers on American archæology and other subjects which she contributed to scientific journals. She was a regular attendant at the meetings of the International Congress of Americanists, and was to a very large extent responsible for the organisation of the meeting held in London in 1912.

We regret to announce the following deaths:

Sir James Reid, Bt., Physician in Ordinary to Queen Victoria, King Edward, and King George, on June 28, aged seventy-three.

Sir Benjamin Simpson, formerly Sanitary Commissioner and Surgeon-General with the Government of India, on June 27, aged ninety-two.

Mr. S. S. Hough, F.R.S., H.M. Astronomer at the Cape of Good Hope, on July 8, aged fifty-three.

Current Topics and Events.

WE print as a supplement to this issue a discourse on muscular work by Prof. A. V. Hill, who will shortly be added to the physiological strength of University College, London. In it Prof. Hill shows how the original work of Fletcher and Hopkins on the production of lactic acid in muscles, the quantitative relationships between glycogen and lactic acid established by Meyerhof, and Prof. Hill's own elegant measurements of heat production, can now be added together into a coherent account of muscular contraction. The actual process which produces the mechanical energy is an explosive decomposition of glycogen into lactic acid, and the mechanism by which shortening of the muscle is caused—though this is of course speculative—is the neutralisation of this acid by bases; these are detached from their combination with proteids, which thereby lose their electrical charges and rearrange themselves in space. This part of the process is anaerobic, and the oxygen which is such a paramount necessity for the achievement of muscular work is needed not for the contraction but for the process of recovery. In this a portion of the lactic acid is oxidised, and provides the energy for the reconstitution of the bulk of the acid to glycogen. It thus becomes clear how it is possible for a man to do for short periods muscular work of a severity which requires sooner or later much more oxygen than he can possibly obtain through his lungs while the work is going on. Hence a man can for a short time run into debt for oxygen and obtain what he needs after the work is finished. For exercise of longer duration this shortage of oxygen cannot be progressively increased, and a man's capacity for it will depend mainly on his capacity for taking in oxygen and circulating it quickly to the tissues. Prof. Hill shows how well the actual record performances for flat racing over various distances fit in with the theoretical considerations. Athletic skill is also determined largely by dexterity in the economical performance of muscular work.

AT the meeting of the Council of the Royal Society on July 5, it was decided to use the larger part of the income arising from Sir Alfred Yarrow's gift of 100,000*l.* for the endowment of research, which was announced in February last, in the direct endowment of research by men who have already proved that they possess ability of the highest type for independent research. To this end a number of professorships will be founded, of type similar to the Foulerton professorships which were founded by the Society in 1922 for research in medicine. The professors will be expected to devote their whole time to scientific research, except that they may give a limited course of instruction in the subjects of their research to advanced students. There is at present a tendency to regard scientific research as a secondary occupation for men whose primary occupation is the teaching of students. The intention of the Royal Society in founding these professorships is to promote the recognition of research as a definite profession.

THE Royal Asiatic Society will celebrate its centenary during the four days, Tuesday to Friday, July 17-20, and the proceedings will be initiated by a reception of the delegates from other societies and bodies at the Royal Society's Rooms, Burlington House, at 10.30 A.M. on Tuesday, when H.R.H. the Prince of Wales has graciously consented to be present. This will be followed by a luncheon given by the Government to the delegates at Claridge's Hotel, and at 3.15 the delegates will meet their sectional chairmen at the Royal Asiatic Society's House, 74 Grosvenor Street, for an important part of the proceedings will be the reading of papers. For this purpose, the whole field of the Society's investigations has been divided into four sections: (1) the Ancient Far East (China and Japan); (2) the Ancient East (Babylonia, Assyria, Egypt, Palestine, etc.); (3) India (including Persia and Ceylon); and (4) Islam. On Wednesday, the morning sessions will be devoted to papers and discussions thereon; in the afternoon a visit will be paid to the School of Oriental Studies in Finsbury Circus, and the Lord Mayor has kindly promised to hold a reception at the Mansion House at 4 o'clock. Thursday and Friday mornings will be occupied by sectional meetings and papers, but the afternoons will be left free to permit the delegates and other associates to make personal arrangements as they may desire, taking advantage of their visit to London. The proceedings will close with a banquet at the Hotel Cecil at 7.30 P.M on Friday. Foreign visitors may enrol themselves on Monday, July 16, at the Society's House, and on Tuesday at the Royal Society's Rooms. Meanwhile any further information may be obtained from the Society's House.

THE list of honours recently issued contains the names of the following men distinguished for their scientific work or associations:— *Baronet*: Sir Anthony A. Bowlby, president of the Royal College of Surgeons. *Knights*: Dr. G. F. Blacker, dean of University College Hospital Medical School; and Prof. W. M. Flinders Petrie, Edwards professor of Egyptology, University College, London. *C.B.*: Mr. R. J. Thompson, assistant secretary, Ministry of Agriculture.

DR. T. ROYDS has been appointed director of the Kodaikanal and Madras Observatories in succession to Mr. J. Evershed, who retired on February 25 last.

SIR STEWART STOCKMAN, Chief Veterinary Officer and Director of Veterinary Research to the Ministry of Agriculture and Fisheries, has been elected president of the Royal College of Veterinary Surgeons.

AT the Cambridge meeting of the Society of Chemical Industry the following officers were elected for the year 1923–24:—*President*: Dr. E. F. Armstrong. *Vice-Presidents*: Dr. T. H. Butler, Mr. F. H. Carr, Prof. G. G. Henderson, Mr. E. Mond. *Ordinary Members of Council*: Prof. P. P. Bedson, Dr. R. T. Colgate, Prof. A. R. Ling, Dr. J. Reilly.

The Report of the Norwich Castle Museum Committee for 1922 gives a picture of the beautiful fifteenth to seventeenth century house known as Strangers' Hall. For many years Mr. Leonard G. Bolingbroke has been filling this with examples of English furniture and domestic appliances, as well as with many relics directly connected with the history of Norwich. He has now generously presented the freehold of the building and his collections to the city, and there was a ceremonial opening on July 4 by the Lord Mayor of Norwich.

Applications are invited for the post of Superintending Testing Officer under the Mines Department of the Government. The person appointed will superintend the testing work at the Mines Department Experimental Station in regard to safety lamps, electrical apparatus, etc., and the work of analysing samples of mine dust and mine air. Applications, accompanied by copies of two recent testimonials, should be sent by, at latest, July 21 to the Under-Secretary for Mines, Mines Department, Dean Stanley Street, S.W.1.

The summer conversazione of the Natural History Museum Staff Association was held in the Board Room on July 4, and was attended by about sixty members of the Staff and visitors. The specimens exhibited were mainly devoted to the exposition of symbiosis, but some dealt with the recent eruption of Mt. Etna, and a demonstration was given of crystals used in wireless telephony. Messrs. W. Watson and Sons, Ltd., showed their latest forms of microscopes and other optical apparatus.

The Belfast Naturalists' Field Club has issued the programme of its sixty-first session, 1923-24, and is to be warmly congratulated on its vitality through the years of Continental warfare and the still more trying years of civil disorder that ensued. Under the presidency of Mr. J. A. S. Stendall, a varied series of excursions has been arranged, mostly within the county of Antrim, which covers so wide a field of botanical and geological interest. One of the most ambitious of these outings, to the majestic and rarely visited volcanic neck of Slemish, took place on June 16. We are glad to note that Mr. R. J. Welch, on whom the Queen's University of Belfast has recently conferred the honorary degree of M.Sc., remains one of the most active promoters of the educational aspects of the Club, and that he is devoting especial attention to the development of the junior branch.

The Minister of Health has appointed the following committee to inquire into the use of preservatives and colouring matters in food: Sir H. C. Monro (chairman), Prof. W. E. Dixon, Sir A. D. Hall, Dr. J. M. Hamill, Mr. O. Hehner, Prof. F. Gowland Hopkins, Dr. G. R. Leighton, Dr. A. P. Luff, Dr. C. Porter, and Mr. G. Stubbs. The committee is to report: "(1) Whether the use of such materials or any of them for the preservation and colouring of food is injurious to health; and, if so, in what quantities does their use become injurious. (2) Whether it should be required that the presence of such materials and the quantities present in food offered or exposed for sale should be declared." The secretary of the committee is Mr. A. M. Legge, of the Ministry of Health, Whitehall, S.W., to whom all communications should be addressed.

The annual meeting of the Chaldæan Society was held at the rooms of the Royal Astronomical Society on Wednesday, July 4. In the absence of the president, the chair was taken by the treasurer, Dr. J. K. Fotheringham, of the University Observatory at Oxford. Reports of work from various local centres were presented. That from Ipswich was considered a specially successful and encouraging record of the season's work. It was reported that the Chaldæan Expedition to Wallal in Australia for the observation of the solar eclipse of 1922 had been completely successful,—being the only expedition sent from England that had met with success. Mr. Clark-Maxwell had now returned, but Mr. Hargreaves was going on to Mexico for observation of the eclipse this year, where Mr. Philip Myring intended to join him. The editor of the *Chaldæan* reported a growing appreciation in library and scientific circles, and expressed his thanks to a number of distinguished astronomers for the support they had given him. He would continue to pay special attention to the needs of amateurs and beginners. The following officers were re-elected for the ensuing twelve months: *President*, Mr. J. Hargreaves; *Treasurer*, Dr. J. K. Fotheringham; *Secretary*, Mr. E. W. Foster; *Librarian*, Mr. G. S. Clark-Maxwell; and editor of the *Chaldæan*, the Rev. D. R. Fotheringham.

Attention may be directed to the following reports which have been recently received: A. E. Verrill (Canadian Arctic Expedition Reports, vol. viii.) describes the Alcyonaria collected by the expedition and gives a revision of a number of other Canadian genera and species, and describes the Actiniaria, adding notes on interesting species from Hudson Bay and other Canadian localities. Both these reports are excellently illustrated. F. Johansen (in vol. vii.) contributes an account of the biology of the Crustacea found in some of the Arctic lagoons, lakes, and ponds, and a detailed report on the Euphyllopoda of the American Arctic.

We have received the fifth volume (1922) of Experimental Researches and Reports, published by the Department of Glass Technology of the University of Sheffield, and collected from the Journal of the Society of Glass Technology. These papers have been mentioned in Nature as they appeared. There are papers on the action of chemical reagents on glassware, the determination of the durability of glass, as well as on more technical matters. The presidential address by Prof. Turner dealt with "The British Glass Industry, its Development and Outlook," and contains some interesting historical material. One "outlook" is interesting to the layman: "It would not be difficult, if the glass manufacturer set about it in earnest, to write up a fearful account of the many-headed hydra, reptiles, and bugs that infect food not protected by glass, and, on the strength of the fright so administered, soon work up a trade the extent of which might be enormous."

THE new catalogue of second-hand books (No. 225) of Messrs. W. Heffer and Sons, Ltd., Cambridge, is of a miscellaneous character, but it contains many works likely to be of interest to readers of NATURE, *e.g.* those dealing with folk-lore, occult literature, and Egyptology. A useful section is that devoted to foreign literature.

MESSRS. NEGRETTI AND ZAMBRA, of 36 Holborn Viaduct, London, E.C.1, have recently sent us a spirit thermometer of a useful pattern for indoor use. It is mounted on a metal frame, the graduations in degrees Fahrenheit being black on a white ground. The bulb is protected by a strong guard made as a part of the frame.

MR. VALENTINE DAVIS, of Noddfa, Wistaston, Crewe, is organising a holiday course in Chamonix, on August 17-September 1. It is proposed to make excursions to various glaciers and passes, using Chamonix as headquarters, and the flora of the district, the geology of Mont Blanc, and similar field-studies will be made. Particulars can be obtained from Mr. Davis.

MESSRS. GEORGE ROUTLEDGE AND SONS, LTD., have ready for publication part 3 of the third edition of Sonnenschein's "The Best Books: a Classified Bibliography." It deals with history and biography, and historical collaterals, and contains particulars of some 24,000 books. The fourth and concluding part will, it is hoped, be published at the close of the present year. It will deal with the sciences, industries, arts, literature, and philology, and contain complete indexes of authors and subjects.

DR. W. BROWN is bringing out through the University of London Press, Ltd., under the title of "Talks on Psychotherapy," the course of lectures recently delivered by him at King's College, London. It will deal with the subjects of functional nerve disease, psycho-analysis, abreaction and transference, the libido theory and melancholia, auto-suggestion, etc. Other books to be published by the same house are three by Dr. Cyril Burt on "The Sub-Normal School Child," entitled respectively "The Young Delinquent," "The Backward and Defective Child," and "The Unstable and Neurotic."

Our Astronomical Column.

CORRECTION TO THE LONGITUDE OF BORDEAUX OBSERVATORY.—A note in the *Journal des Observateurs* for June, by J. Trousset and L. Gramont, contains the rather surprising announcement that the accepted value of the longitude of the Bordeaux Observatory is a second of time in error. This was based on an elaborate determination, made in 1881 by MM. Rayet and Salats, both observers and instruments being interchanged. The amount is altogether beyond the probable error of the determination, and presumably arose from some systematic error in marking the seconds on the chronograph tapes, or some similar cause.

The error was detected by the reception of the Paris wireless signals at Bordeaux, and a new determination of the longitude was then made by means of these signals. The resulting value of the longitude of Bordeaux west of Greenwich was $2^{m}\ 6{\cdot}564^{s}$, the mean error being $0{\cdot}023^{s}$. The old value, printed in the Nautical Almanac, is $2^{m}\ 5{\cdot}51^{s}$.

The new determination, though only just published, was made in April and May 1921; presumably it was in use throughout 1922 in the wireless time signals sent out from Bordeaux and received at Greenwich. The mean difference between the Greenwich times of receipt of the Paris and Bordeaux signals was only $0{\cdot}04^{s}$.

SILICON LINES IN B-TYPE STARS.—In the determination of the radial velocities of B-type stars, the wave-lengths of the lines of silicon are constantly being used, but the values employed have not been referred to modern standards of wave-lengths. The lines in the spectrum of silicon alter as the temperature is increased and the enhanced or ionised lines occur as doublets and triplets alternately and are known as Si II, Si III, and Si IV as first differentiated by Sir Norman Lockyer. A new determination of the wave-lengths of those lines has just been completed by Mr. H. Barrell in the laboratory of Prof. Fowler (Mon. Not. R.A.S., vol. 83, p. 322), and he gives both the adopted values in International Units and in Rowland's scale. While the instrument employed in the determination was not the one that was most desired, since the latter is still in detention in Russia, that employed gives, as is stated, "the desired redeterminations with every possible precaution to ensure a high degree of accuracy." As the silicon wave-lengths are in very general use it is important that these new values should be widely known; they are briefly summarised below:

Group of lines.	Adopted values in I.A.	Probable errors.	Wave-lengths in Rowland's Scale.
Si II . . .	3856·021	±0·001	3856·165
	3862·592	0·002	3862·737
	4128·053	0·001	4128·207
	4130·884	0·001	4131·038
Si III . . .	4552·611	0·002	4552·782
	4567·824	0·002	4567·995
	4574·737	0·002	4574·908
SI IV . . .	4088·863	0·001	4089·016
	4116·104	0·002	4116·257

A VARIABLE OF VERY SHORT PERIOD.—Mr. F. C. Jordan, of Alleghany Observatory, contributes a note to *Astron. Journ.*, No. 821, on a star of magnitude about $11\frac{1}{2}$, on the same plate with the Cepheid variable S Comae; the period of light-variation is only $2^{h}\ 50{\cdot}8^{m}$, the light-range being 0·73 mag. The light-curve is very pointed at minimum, there being no stationary interval. There is none at maximum either, but the curve is here rounded, not pointed. From comparison with some similar curves it is thought likely that the star is of the Beta-Lyræ type rather than the Algol type; in this case the period will have to be doubled. The two portions of the curve are so alike that in this case the two stars must be very similar in size and brightness. It is feared that the star is too faint to decide the matter by spectroscopic determinations of the radial velocity.

The approximate position of the star for the equinox of 1900 is R.A. $12^{h}\ 28^{m}\ 4^{s}$, N. Decl. 27° 16·1′.

Research Items.

Cancer in the United States.—The incidence of cancer in the United States is discussed by Dr. F. Hoffman in an article in the *World's Health* for May, p. 18. In the general registration area, the cancer death-rate has increased from 74·4 in 1911 to 83·4 in 1920 per 100,000 population, but in some of the individual States is much higher, and, making all allowances, the conclusion is that cancer is seriously on the increase. A dangerous phase of the cancer problem is that alleged cancer cures are gaining in popularity, with results disastrous in the end. Dr. Hoffman states that having personally investigated the incidence of cancer among Indian tribes in the south-west and in Bolivia, he is satisfied that malignant disease in any form, and particularly cancer of the breast, is extremely rare.

The Teeth of Piltdown Man.—In the *American Journal of Physical Anthropology* (vol. vi., April-June), Dr. Aleš. Hrdlička publishes an important contribution to the study of the phylogeny of man in a paper on the dimensions of the first and second molars, and their bearing on the Piltdown jaw. Dr. Hrdlička has subjected to a detailed analysis the recorded measurements of these two molars in man, and has made a careful examination of the material in the U.S. National Museum. As a result, his conclusions are that the Piltdown molars are longer and have a lower index than any group of modern men; as compared with early man they exceed in length all prehistoric molars except one or two first molars from Krapina, and, with one exception, present the lowest breadth-index; in breadth they are ordinarily human. When compared with the apes it is clear that they do not belong to this group, though nearest in proportion to the gorilla. Of the fossil apes, the teeth most closely resembling the Piltdown teeth are those of *Dryopithecus rhenanus*, Pohlig, of the Bohnerz Alb. Dr. Hrdlička's general conclusion is that the Piltdown teeth, primitive as they are, belong to very early man or to his very near precursor, while he suggests that the resemblance to the late Miocene or early Pliocene human-like teeth of the Bohnerz Alb. may legitimately raise the question whether man may not have evolved altogether in Western Europe.

Human Sacrifice as a Rain Charm in Northern Rhodesia.—In January last a report appeared in the *Times* which stated that eighty natives had been arrested in Rhodesia for complicity in a case of human sacrifice due to witchcraft. This report was of peculiar interest in view of the fact that the natives of this region, which lies about forty-five miles beyond Mount Darwin, just on the boundary of Portuguese territory, are noted for their addiction to witchcraft in a form which presents some remarkable parallels to the traditional rites and practices of European witches. From the evidence given at the trial, of which an account is given in the *Times* of June 26, it would appear that in this instance it was not a case of witchcraft in the generally accepted sense. The sacrifice was offered by the Mtawara tribe to propitiate Mwari, the Great Spirit of the tribe, and thus bring to an end a drought which threatened the tribe with disaster. Mwari has two wives. One came some generations ago from a branch of the tribe living in what is now Portuguese territory and was domiciled within a circle of trees, presumably a sacred grove. This wife, Mashongavudzi, is an old woman, past child-bearing, whose husband is dead. At her death her place is taken by another old woman who assumes the same name. The second wife, Nechiskwa, is chosen from the family of Gosa, the chief of the branch of the tribe in Portuguese territory, when a child—the present holder of the office is about nine years old—and must remain a virgin throughout her life. She is the Rain Goddess. When there is a drought Gosa sends an offering of *limbo* (coloured cotton print) to the Mwari, which is placed near the throne of the Rain Goddess. If rain fails to follow, Mwari is angry because some one has seduced his wife. The only remedy is that the culprit should be sacrificed by fire. In this case suspicion fell on a son of the chief who is in charge of the wives of Mwari—an office which has descended to him from his ancestors. The accused man was duly offered up as a sacrifice by burning and, curiously enough, rain followed in twenty-four hours.

Kata-thermometer Studies.—Dr. Leonard Hill's campaign against the stagnant, warm atmospheres which are encouraged by many of the modern plans of warming and ventilating buildings is steadily gaining the success it deserves. Cool moving air and local radiant heat mean a cool head and warm feet, which is the ideal state for human comfort and efficiency. The stimulating qualities of an atmosphere depend on its temperature, humidity, and movement, and in the kata-thermometer Dr. Hill introduced an instrument which gives directly a measure of the cooling and evaporative powers of the air; *i.e.* the properties which through their action on the skin determine the pleasantness for man. "The Kata-thermometer in studies of body heat and efficiency" (Medical Research Council Special Report Series, No. 73, 1923) gives a mass of data collected by Dr. Hill, Dr. H. M. Vernon, and others, under a variety of conditions ranging from boot and shoe factories to imitations of shipwrecked sailors in the wind tunnel at Hampstead. There is also a discussion of the theory and practice of the instrument and a description of a recording apparatus designed by Dr. E. H. J. Schuster. The section on the relation of general metabolism to kata-thermometer readings raises a question of considerable importance to which no answer seems to be yet available. Atmospheres which are "good" by Dr. Hill's standard increase metabolism, and more food is needed and desired. Riding on the top of a bus, for example, instead of inside, means, as he points out, a greater expenditure on food. It is also generally agreed that it promotes general healthiness and vigour. But why is it that a high rate of metabolism is better for the body than a low rate? The effect may be essentially psychological, but the point requires discussion. The whole report will well repay detailed examination.

Tsetse Flies.—The April issue of the *Bulletin of Entomological Research* contains a report of Drs. W. B. Johnson and L. Lloyd on tsetse fly investigation in the northern provinces of Nigeria. The authors bring forward evidence showing that sleeping sickness can appear and become epidemic in localities where the only tsetse carrier present is the species *Glossina tachinoides*, and it is at least probable that this insect is responsible for the disease in certain localities where it abounds and the usual carrier *G. palpalis* is rare, or wanting. Both *G. palpalis* and *G. tachinoides* suck the blood to a considerable extent of the non-mammalian fauna—probably that of reptiles. The two species can thrive where the wild fauna is reduced to its possible minimum, and *G. tachinoides* where man is almost the only available host. The authors anticipate that

the work of controlling the latter species will resolve itself into a study of the problems of clearing the jungle, since curtailment of its food supply does not appear likely to be effective. In the same journal Dr. G. H. D. Carpenter contributes an article on the use of artificial breeding places as a means of control of *Glossina palpalis*. The breeding places took the form of low thatched sloping roofs erected over suitable loose soil in localities where the fly is known to abound. The insects used the shelters as convenient places for depositing their larvæ, which very soon afterwards pupate. The result of the catches from these shelters showed that in some cases they were superior to the natural places selected by the flies. It is concluded that, although the method affords a ready means of collecting material for laboratory investigations, it is ineffective as a means of destroying the Glossina without other measures. After very nearly a year the number of pupæ deposited showed no appreciable diminution.

BRITTLE-STARS OF THE PHILIPPINES.—The Smithsonian Institution has recently published, as volume 5 of its Bulletin 100, a memoir by Prof. R. Koehler on the Ophiurans collected by the *Albatross* in Philippine and Samoan waters. Out of the 227 species discussed, 68 are new, and these include examples of 5 new genera. Since many of the other species had previously been inadequately described, they too now receive full description and illustration. The illustrations are entirely photographic, a method which Prof. Koehler claims as the only satisfactory one for the systematist. When the photographs are as good and as well-reproduced as are most of Prof. Koehler's, and when, as here, enlarged photographs of details are provided, then, on the whole, we agree with this claim. But even when all the conditions are fulfilled, explanatory diagrams are a most welcome addition. The classification adopted is that of Matsumoto, with a few modifications of detail (but why Lœmophiurida instead of Læmophiurida ?). The work has been translated from the French by Mr. Austin H. Clark into clear and easy English: we would observe only that the English for "Lyon" is "Lyons."

FOSSIL BISON FROM CENTRAL MINNESOTA.—From a peat swamp overlying the iron ore at the Sagamore Iron Mine, Riverton, Minnesota, bones of *Bison occidentalis* have been recovered which form the subject of a paper by Mr. O. P. Hay (Proc. U.S. Nat. Mus., vol. lxiii., art. 5). The bones were at or near the bottom of the peat, which overlies drift beds determined to be of about mid-Wisconsin age, so that *Bison occidentalis* lived in Minnesota until the middle of the last glacial stage, but how much longer cannot now be determined. Whether the presence of the remains of *Bison bison*, that also occurred in the peat, indicates that the two animals were at one time contemporaneous in that region, or whether the existing buffalo arrived there after the other had become extinct, is uncertain.

GIANT HORNLESS RHINOCEROS FROM MONGOLIA.—In 1913 Mr. Forster Cooper described under the name of *Thaumastotherium* (afterwards altered to *Baluchitherium*) *osborni* a huge rhinoceros-like animal of which he had unearthed the remains on his expedition to Baluchistan. A second species, *B. grangeri*, was discovered at Loh, central Mongolia, in 1922 by the third Asiatic expedition of the American Museum of Natural History. This new species is now described by Prof. H. F. Osborn (Amer. Mus. Novitates, No. 78), who further makes the genus the type of a new subfamily—Baluchitherinæ. The author considers that the Baluchitheres will prove to be unique, large animals of the age (Upper Oligocene, or Miocene) in which their remains occur, and that they were typical browsers feeding on the branches of trees as do elephants and giraffes. When the neck was elevated and stretched the animal would have attained a height of about fifteen, or possibly sixteen feet. A restoration is given which shows that at the shoulder Baluchitherium was twice the height of the Indian rhinoceros with which it is compared.

LATE MESOZOIC BATHOLITES AND ORE-DEPOSITS IN JAPAN.—While the attention of geologists is being justly redirected to the major "revolutions of the globe," and to the relative rapidity of their culminating episodes, it is well to note the evidence of intervening epochs of unrest. The "Laramide revolution" of Schuchert, which is held by many to have heralded the great days of Andean crumpling, can be traced back to "epeirogenetic" movements in the Rocky Mountain area in late Cretaceous times; and these are now seen to have had "orogenetic" analogues on the other side of the Pacific. Here we may observe, as a corrective of too rigid doctrine, that the folding took place on the eastern side of a continental mass. Prof. T. Kato of Tokyo (*Japanese Journ. of Geol. and Geogr.*, vol. i. p. 77, 1922) describes the intrusion of huge batholites of quartz-diorite and granite into Jurassic strata in central Japan, and he traces the famous copper-ores of the Yamahara district in the province of Mimasaka to a late Mesozoic epoch of unrest. The first result of the igneous intrusions was the contact-metamorphism of the sedimentary series. Then, at a temperature a little below the critical point of water, tourmaline and fluorspar were produced; and the sulphide ores, including copper and iron pyrites, pyrrhotine, and zinc-blende, followed, and permeated the invaded areas. Veins of quartz and calcite mark the final stage. A neat diagram on p. 99 shows the succession of igneous types, closing with rhyolites that reached the surface. Volcanic manifestations continued into Cainozoic times; but the epoch of maximum disturbance is assigned to the close of the Mesozoic era. The paper is written in English and is very well illustrated by photographs.

PETROGRAPHY OF DRILL-CUTTINGS FROM OIL-WELLS.—One of the first attempts in the United States towards the intensive petrographic examination of rock-samples obtained while drilling oil-wells, is described in an advance chapter (H) of bulletin 786 of the United States Geological Survey, by Messrs. J. Gilluly and K. C. Heald. Their report deals with the stratigraphy of the El Dorado oilfield, Arkansas. Petrographic methods of correlation of strata have come into prominence in England and in several of the British-owned oilfields within the last seven or eight years, but, so far as we know, little attention has been paid by oil-geologists in the United States to this phase of exploratory work. The authors rely entirely on the lithological characters of the samples, on their differentiation according to the amounts of sand, clay, and lime present, while limonite, lignite, or glauconite are specifically indicated where sufficiently obvious. Any fossils found are also carefully studied in conjunction with this petrographic investigation, a collaboration to be highly commended. It is, however, unfortunate that the authors did not go a great deal further with their petrographic work; the "heavy" detrital minerals (*i.e.* those having a specific gravity greater than 2·8) furnished by the samples would have formed a much more definite basis of comparison

and discrimination between the beds involved, and zoning would have been facilitated accordingly. Authigenous constituents of sediments vary qualitatively and quantitatively within small limits far more than the more stable detrital grains do, and for this, if for no other reason, the study of the "heavy" minerals is always desirable. Notwithstanding the neglect of these constituents, however, the authors have grouped their samples into ten zones, comprising parts of the Tertiary and Upper Cretaceous formations in the district; such zones are of incalculable value to the drillers and others engaged in exploring the field, but it would be interesting to know how far such zones were confirmed or contradicted by similar work based on 'heavy" mineral assemblages.

BRACHYSTEGIA, A TROPICAL SOURCE OF FIBRE AND TIMBER.—Messrs. J. Burtt Davy and J. Hutchinson describe fifty-four species of Brachystegia in the *Kew Bulletin*, No. 4, 1923. This genus is confined to equatorial Africa, and is so dominant in the vast forest area extending between the Limpopo Zambesi watershed and the Katanga Plateau at the head waters of the Congo River, and from Nyasaland to the Angola Highlands, that this plant formation might well be termed "Brachystegia Forest." All species are trees with fibrous bark, sometimes containing tannin, and the natives of Central Africa use this bark for an extraordinary variety of purposes. Brachystegia bark cloth is used for making grain sacks and game nets, the fibres of some species being used for the manufacture of cord and rope of all sizes and for all purposes. Before the widespread introduction of cotton goods, the principal clothing of the native was bark cloth made of fibrous sheets beaten out of the bark of several species of Brachystegia. The timber of some species is described as hard and durable and suitable for building purposes, that of others as too soft. Undoubtedly both fibrous bark and timber may have many industrial applications, but the first step towards economic development is a clear idea of the different species of the trees and their different possibilities. To this end the taxonomic study in the *Kew Bulletin* should have great value, as one of the authors has studied the plants in their native habitat and a first attempt is made to indicate what different species are probably intended by the vernacular names used by the natives.

LIBERATION OF PRUSSIC ACID FROM THE PLANT LEAF.—The highly toxic properties of hydrocyanic acid have caused the accumulation of a considerable literature upon the subject of its production in plant tissues from cyanogenetic glucosides under various conditions. The problem is obviously not simple, and, as occasional cases of stock poisoning are traced to this source, its study has economic as well as scientific interest. F. J. Warth has recently studied the liberation of prussic acid from the tissues of the Burma bean (*Phaseolus lunatus*), and supplies some very interesting data in the Memoirs of the Department of Agriculture in India (Chemical Series), vol. vii. No. 1. He points out that the amount of prussic acid produced differs materially according to whether the leaves are dried rapidly in the sun or slowly in the shade. In the sun-dried leaf, hydrolysis takes place with evolution of prussic acid, and if the dried leaf be plunged into boiling water further large amounts of the acid are given off; this effect is not produced with the fresh leaf or slowly-dried leaf. It appears that in the slowly dried leaf the enzymic balance approximates to that in the normal leaf, and in this balanced system prussic acid appears to be further changed as rapidly as it is released by enzymic hydrolysis of the glucoside; indeed, both fresh leaf and slowly dried leaf show some capacity to cause the disappearance of additional acid, if added to water containing the crushed or powdered leaf material.

SHORT-WAVE DIRECTIVE RADIO TRANSMISSION.—Franklin and Marconi have shown that when the wave-lengths used in radio transmission are less than 20 metres it is not difficult to get directive transmission. For transmitting news and music, broadcast directive transmission is not wanted, but for broadcast reception it can be usefully employed, as by its means interference disturbances may be reduced to a minimum. Its principal use is in connexion with point-to-point communication, *i.e.* direct communication from one transmitting to one receiving station. In particular it will be useful in the new methods adopted of transmitting photographs by radio and for the remote control of mechanisms. In paper No. 469 published by the Bureau of Standards, F. W. Dunmore and F. H. Engel give the results of experiments with directive radio transmission on a wave-length of 10 metres. As a reflector they use a series of forty vertical parallel wires all of which lie on the surface of a parabolic cylinder. It is so mounted that it can be rotated about a vertical axis. The focal length of the parabolic section was made one-quarter of a wave-length, 2·5 m. (8 feet 2·4 inches). Each of the wires was tuned to 10 metres, and they were spaced 30·47 cm. apart. A 50-watt three-electrode valve of the coated filament type was used as a generator. Radiation characteristic curves are given from which it appears that at least 75 per cent. of the radiated power is confined to an angle of 40°. It was noticed that with this type of transmission the absorption by buildings and other metallic structures was very pronounced.

WEATHER AT EASTBOURNE IN 1922.—Eastbourne Borough Council has recently issued its annual report of the meteorological observations for the year 1922. The records have been kept continuously since 1887, a period of 36 years, so that valuable statistics are available as to the weather and climate of this much-favoured health resort. Observations are supplied to the Meteorological Office and are included in the Weekly, Monthly, and Annual Weather Reports, as well as in the Daily Report of Health Resorts. In addition to the observations at Eastbourne the report comprises similar results for other health resorts scattered over England, taken from the Meteorological Office returns, from which it can be seen that Eastbourne occupies a position with a fairly equable temperature, with a large amount of sunshine, and with a rainfall by no means excessive. The mean air temperature in 1922 ranged from 59·2° F. in August to 41·6° F. in January, and the mean for the year was 49·9° F. The duration of sunshine ranged from a mean of 10·40 hours per day in May to 1·76 hour per day in December, the mean for the year being 4·80 hours per day. The mean monthly rainfall for 1922 ranged from 4·31 in. for January to 0·61 in. for May; the total for the year was 28·10 in. The prevailing winds were from the west and north-west, though in most recent years the prevailing winds have been from between south-west and north-west. From this prevailing direction the air has to pass over the South Downs before reaching the town, and, mixing with the air over the sea, may often account for a fair amount of fog in the Channel, in the neighbourhood of the *Royal Sovereign* Lightship, and frequently may render the air somewhat humid over the land.

The International Air Congress, 1923.

THE second International Air Congress since the War was held in London on June 25-30. It was attended by about 600 members representing no less than 20 countries. The Duke of York was president of the Congress, and the Duke of Sutherland, Under-Secretary of State for Air, chairman of the committee. The Congress was opened on June 25 with an address from the Prince of Wales. During the week the meetings for papers and discussion were held in the buildings of the Institution of Civil Engineers. Three days were devoted to these, while two were utilised in visits to works and places of interest to the members. Thus on Tuesday a large party visited the Royal Aircraft establishment at Farnborough, while on Thursday the National Physical Laboratory attracted many interested members.

In addition to the official gatherings, receptions were given by the Lord Mayor and the Duchess of Sutherland, while on Friday afternoon the Secretary of State for Air and Lady Maude Hoare entertained the Congress at a garden party at which the Duke and Duchess of York were present. Saturday was devoted to a final meeting, with the Secretary of State for Air in the chair, at which a number of resolutions were passed. The Congress then adjourned to Hendon to view the Royal Air Force Pageant, and the week closed with a successful banquet, with the Duke of Sutherland in the chair. Colonel Lockwood Marsh, secretary of the Royal Aeronautical Society, was secretary of the Congress, and received the very cordial thanks of the Congress for the admirable arrangements by which its success was secured.

For the papers and discussions the Congress divided into four groups, as follows:—(A) Aerodynamics, construction and research; (B) power plants—fuels, lubrication, airscrews, etc.; (C) air transport and navigation; and (D) airships.

In each of these a number of interesting and important papers were read; the papers, with the discussions, will be issued shortly in book form. Readers of NATURE will probably find most to interest them in Group (A).

Some fifty years ago Lord Rayleigh directed attention to the effect of circulation of air round a cut tennis ball, having spin, as well as forward velocity, in modifying the motion of the ball and causing it to follow a curved path. In his well-known book on aerodynamics, Lanchester applied the same idea to account for the lift on an aeroplane wing, and described the manner in which the vortex system set up round the wing was completed by two series of trailing vortices shed off from each wing tip. These carry away part of the energy and thus give rise to a portion of the drag—known now as the induced drag—which resists the motion of the aeroplane.

Lanchester's work was descriptive and its importance was scarcely recognised; numerical results, figures, and mathematical calculations were needed before its great value was grasped. We now see that it contains the solution of the problem; the intuitive eye of the genius forestalled the slower methods of the mathematician, though laborious calculations and the work of expert draughtsmen and experimenters were necessary to establish its fundamental truths. Several of the most important papers in Section A were devoted to this subject.

Starting from the known solutions of the flow round an infinite cylinder moving uniformly in a fluid in which there is circulation round the cylinder, Joukowsky and Kutta transformed the motion into one about a long cylindrical body having a section resembling that of an aeroplane wing, but with an infinitely thin trailing edge. They obtained an expression connecting the lift on such a wing supposed to be of infinite aspect ratio—*i.e.* infinitely long in comparison with its width in the direction of flow—with the circulation. The motion is thus two-dimensional in planes at right angles to the length of the wing.

One of the stream-lines near the tail leaves the wing at right angles to its upper surface, and unless this point coincides with the trailing edge the motion breaks down and the velocity becomes infinite. By adopting a suitable value for the circulation the stagnation point can be brought into close coincidence with the trailing edge, the motion becomes steady, and the lift can be determined; the value so found is, however, some 20 per cent. too great, and the theory does not account for the drag. There would be no resistance to the motion of such a wing.

Major Low, in one of the papers read to the Congress, gave an interesting account of a draughtsman's method of applying the Joukowsky theory to a wing of any form.

This simple two-dimensional theory was modified by Prandtl and his school. He assumes the wing to shed vortices all along its trailing edge from the centre outwards, forming a vortex sheet which at a little distance behind the aeroplane rolls up into a single long vortex trailing away from each wing tip in a direction opposite to that of motion, as in Lanchester's suggestions. Thus the circulation, and hence the lift, falls off as one passes outwards along the wing; and, assuming a law for its decrease, Prandtl obtains an expression for the lift on a wing of finite aspect ratio, and, by taking into account the effect of the trailing vortices, for the drag considered as due to the action between these and the wing vortex—the induced drag. This accounts for a large percentage of the observed drag. In England, Mr. Glauert has done much in connexion with this theory, which has been applied to the interference of the channel walls on a model under test, to the theory of the propeller leading to Froude's coefficient of 0·5 for the induced flow near the propeller, and to other problems. Mr. Glauert's paper gave an important résumé of the present position.

But there is a fundamental difficulty: the fluid is treated as inviscid, and in such a fluid the motion of a body will not set up vortices; the body will experience no drag. Air is viscous, and the value of the kinematic coefficient of viscosity has an important bearing in aerodynamics, while the shearing forces set up by the viscosity depend on the rate of change of velocity in the direction normal to the flow. Now, since the fluid, if viscous, is at rest relative to the body at all points of its surface, the rate of change of velocity, and therefore the viscous shear, will be greatest close to the surface. The Prandtl theory supposes that such viscous forces are sensible only throughout a very thin film surrounding the surface, which suffices to set up the circulation, and that outside this film the equations of an inviscid fluid may be used.

Prof. Bairstow in his paper, after a reference to his recent communication read before the Royal Society, suggested that an attempt to relate the circulation theory to the fundamental equations of motion, taking viscosity into account, would lead to a determination of the friction on the surface of the aerofoil, thus giving that part of the drag which is omitted from the Prandtl theory. Promising work on these

lines is in progress in the Aeronautical Department of the Imperial College, South Kensington, which is thus beginning its work as a centre of advanced research.

To turn to other parts of the discussions in Group (A), mention must be made of a most important paper by Mr. Handley Page on the slotted wing. The author gave the most recent details of his wind-channel tests on his device for enabling the pilot to increase effectively the lifting power of the wing. This enables him to land at a much lower speed than would be otherwise possible. Reference must be made to the paper for the figures; it must suffice to say that in the case of one section known as Airscrew 4 the maximum lifting coefficient was increased from 0·7 to 1·1, while for the well-known section R.A.F. 15 the increase was from 0·55 to 0·95. The meeting was pleased to hear from the representative of the Royal Air Force that the full-scale tests, so far as they had been completed, were successful.

Methods of measurement in experimental work were discussed in various papers. Col. Robert, of the Technical Aeronautical Service of France, gave a detailed account both of the precautions necessary to secure accuracy in the results and of the delicacy of the tests, thus confirming the experience of the workers at the National Physical Laboratory, Teddington. Our French colleagues are to be congratulated on the possession of the new air-channel which is now being installed. The channel is 3 metres, say 10 ft., in diameter, and the maximum air speed 30 metres, or about 100 ft. per second. The standardisation, or rather the intercomparison, of methods of research was discussed by Sir Richard Glazebrook in his paper dealing with the international tests now in progress. Mr. Southwell described the most recent apparatus at the National Physical Laboratory, and Mr. M'K. Wood dealt with the accuracy of model results and their comparison with full-scale work.

Among the other papers, one by Mr. Baumhauer, of the Dutch Institute for Aeronautics, on the methods of computing wing sections, met with general approval, while Mr. North's paper on the technical development of the aeroplane aroused much interest. It must suffice to mention them, together with the papers on stability by Mr. Barlow; on control at low speeds, by Mr. M'K. Wood; and on testing of strength, by Mr. Douglas. Another paper by Messrs. Baumhauer and Groning dealt with the vibrations of an aeroplane wing, a subject which is being investigated both at the National Physical Laboratory and at Farnborough.

It will be obvious from the above that those members of the Congress who attended Group (A) were kept fully occupied with interesting and important problems.

And now to conclude; limits of space forbid anything but the briefest reference to the other papers, not that they were less interesting or less important than those of Group A. There is no one better able to speak on airship travel than Major Scott, with his experience of two voyages across the Atlantic. Colonel Richmond is an authority on airship structure, while Signor Nobili has acquired a world-wide reputation from the success of the Italian ships. Some comparison of their performance with those of our own non-rigids would be interesting. Moreover, full-scale experimental work, if airships are to be constructed on a scientific basis, is still required, though our knowledge has been increased by recent American work.

Members attending Group B were interested in various papers connected with engines, such as Mr. Charlton's account of the crude oil engine, Wing-Commander Hyne's description of engine work at Farnborough, and the communications on lubrication by Dr. Stanton, Mr. Evans, and Mr. Hersey, while on Wednesday morning the discussion on air mails and the development of commercial aviation by General Williamson, Jonkherr van Hemstede, and Mr. Handley Page attracted a large and attentive audience to Group C. In every way the Congress proved a great success, and its members acclaimed Sir Samuel Hoare's toast at the concluding meeting, "To our next merry meeting, Brussels, 1925."

The National Physical Laboratory, Teddington.

ANNUAL VISITATION.

ON Tuesday, June 26, the General Board of the National Physical Laboratory made the annual visitation to the Laboratory. As is customary on this occasion, a number of members of scientific and technical societies and institutions, government departments, and industrial organisations were invited, and the Laboratory was open for inspection. The visitors were received in the new aerodynamics building by Sir Charles Sherrington, chairman of the Board, Sir Arthur Schuster, and the director of the Laboratory.

Since the last visitation the Laboratory has been somewhat extended, and Victoria House, acquired a few years ago to meet the anticipated increased demands of the work, has been converted for the use of the Physics Department. Most of the temperature work involving the testing and standardisation of mercury, resistance, and optical pyrometers is carried out here, in addition to the investigations of the newly created sound section. The Metallurgy Department has been provided with much-needed increased accommodation by the addition of a new story to the Wernher Building, in which a number of offices and small laboratories, as well as a special room for high temperature work, have been equipped.

A very large number of interesting exhibits were shown in the various departments. It is, however, impossible to do more than describe briefly a few of the more noteworthy, which show the wide range of phenomena, from the highly theoretical to the severely practical, which the Laboratory is called upon to investigate.

In the Aerodynamics Department the wind-tunnels were shown in operation. In the duplex wind-tunnel, which has a working portion 14 ft. wide, 7 ft. high, and 80 ft. long, two motors of 200 h.p. develop wind speeds up to about 110 ft. per sec. (75 miles per hour). A test on a Bristol Fighter aeroplane was demonstrated in which, on a model (¼ full size) having a motor-driven airscrew, an experimental investigation of the effect of slip-stream on the behaviour of the plane is being carried out. The "whirling arm," which is driven through a worm gear by a 12-h.p. motor giving speeds of advance up to 50 ft. per sec., was shown employed in the determination of the pressure distribution on ellipsoids travelling in circular paths. This has an important application in the deduction of the stresses imposed on the hull of an airship which is turning.

Another interesting exhibit showed an electrical method of determining the stream-lines of an inviscid fluid past an aerofoil of any given section. It can be shown theoretically that the equipotential lines of a system consisting of an insulated conductor between two charged parallel plates are identical in form with the stream-lines in a perfect fluid flowing

parallel to the plates past the same conductor. By the use of exploring electrodes connected to telephones through a three-valve audio-frequency amplifier, it is possible to determine positions of the electrodes which reduce the sound in the telephones to a minimum, and hence obtain the equipotential lines of the system, or the stream-lines for the case of fluid flow.

In the Engineering Department a new method of testing the efficiency of gear-boxes was shown in which the difference of the input and output powers is measured directly and not as a difference. The method consists of the observation of the torque produced as a consequence of the difference of the input and output powers when the gear-box was supported in a tilting frame. Apparatus was shown for the study of explosions in closed vessels. This has an important application in the design of internal combustion engines where it is desirable that the explosions should occur under the most favourable conditions of temperature and pressure of the mixture. This is, of course, largely influenced by the compression ratio, which is, however, limited in effect by detonation or "knocking" at high compression ratios.

In connexion with the experimental study of roads and road materials a new plant for the preparation of bituminous macadam was exhibited. The plant consists of two units, one for mixing sand, etc., at a temperature of 600° F., and the other for mixing the aggregate with bitumen. It is capable of mixing about six tons of road metal per hour. Other exhibits included apparatus for the investigation of fatigue under uniform bending moment, and its correlation with the microstructure of the material; the endurance of ball-bearings under axial loading; and the hardness of materials as tested by their ability to resist scratching by a diamond.

The main exhibit in the William Froude National Tank was the method of determination of the stresses liable to be set up in the rudder heads of ships when the rudder is altered in certain definite ways. The problem is one on which attention was focussed during the War, when even with vessels which were classed A1 at Lloyd's damage to stearing gear was of much more frequent occurrence than was anticipated. For this purpose a ship model capable of independent motion and external control was under observation from the travelling carriage of the tank, and the effect of putting the helm over at various rates and through different angles investigated. The experiments show that it is possible to add more than 50 per cent. to the strain on the rudder head by changing the helm too quickly.

Other exhibits included apparatus for determining the stresses on a rudder behind a fin plate with twin screws, and for the determination of the resistance, rise, and angle of seaplane models in motion.

In the Metrology Department standard weights were exhibited. In this connexion it is interesting to note the experiments of the Laboratory on a new material, stellite, as a substitute for platinum for standard weights. Stellite, which is an alloy of chromium, cobalt, and tungsten, is exceedingly hard, and tests made on these weights show that it has great promise as a platinum substitute. The weights have been under observation for two years, and have shown that stellite possesses great stability; weights made of it remaining constant to less than 1 part in 10,000,000 over that period.

A new gear-measuring machine was also exhibited; with this machine it is possible to measure the pitch of teeth, tooth-shape, and thickness, concentricity of teeth with the gear axis, parallelism of teeth with the axis, radial symmetry of teeth, and the pitch diameter. By ingenious arrangements the profile of the successive teeth can be magnified and made visible on a smoked glass and examined by projection methods, while the variation from uniform motion of two gears in mesh can also be critically examined.

A travelling microscope, in which many of the errors prevalent in the usual form of travelling microscope are eliminated, was demonstrated. In addition, the instrument, by suitable gearing, gives results simultaneously in inches and centimetres to a ten-thousandth of an inch or centimetre.

The exhibits in the Electrotechnics Division included the experimental arrangements for precision resistance measurements, for research on buried cables, for the determination of the errors of current transformers, and for the photometric measurement of lamps. An interesting demonstration of the attraction of the suspended particles in oil to electrodes at high potentials showed how such impurities can diminish the insulating properties of oils used for insulating high-tension apparatus. The illumination building in which experiments on the window efficiency of rooms are carried out was also open for inspection.

The end hardening of gauges, which was investigated in conjunction with the Metrology Department, was also shown here. The gauge is made one electrode in a furnace and passes a heavy current through a piece of graphite, which is thereby heated to a high temperature. The portion of the gauge in contact with the graphite thus attains a temperature considerably above the critical temperature for steel, and on dropping into water all the portion which was above the critical temperature is very effectually hardened. In this way only a very small proportion of the material of the gauge is interfered with in the hardening process.

The Wireless Division's exhibits consisted of apparatus for measuring both the direction and intensity of the electro-magnetic field from a distant radio transmitting station, and for applying these measurements to the study of the propagation of electro-magnetic waves over the earth's surface. To assist in this study of radiation problems, a transmitting station using both damped and undamped waves has been erected. An earth screen is employed at this station with various forms of antennæ. Apparatus was also shown for the absolute measurement of the amplification produced by a valve amplifier at audio-frequencies: this is used for the testing and investigation of both valves and their coupling transformers.

In the Radiology Division a Bragg spectrometer was shown in operation for the examination of the structure of metals and alloys. The method is a modification of the powder method of determining crystal structure, and has been extended to several systems of alloys, including copper and aluminium, copper and nickel. In each case it is found that in solid solution the solute atom enters into the lattice of the solvent by substitution. The structures of such metallic compounds as $CuAl_2$ and AgMg have also been determined by this method. Apparatus consisting of a spherical ionisation chamber for the investigation of the scattering of X- and γ-rays was also shown. This problem is of interest in connexion with deep therapy treatment using X- or γ-radiations, where, unless suitable precautions are taken, it is possible to obtain several times the desired exposure due to the scattering effect of surrounding tissues.

In the General Physics and Heat Divisions the exhibits were mainly of apparatus for determining the thermal constants of materials. Among these were a special calorimeter for use with substances that react with water, new forms of immersion

heaters for use at high temperatures, and apparatus for determining the thermal conductivity of metals up to within a few degrees of their melting-points. Other apparatus exhibited was concerned with the production of sounds of constant intensity and frequency, and with the reflecting and absorptive properties of materials for sound waves. A high vacuum two-stage mercury pump was also shown, by which pressures of less than 10^{-6} mm. of mercury can be obtained with a supporting pressure of 4 mm. of mercury. The exhaustion speed for both gases and vapours is extremely high, and drying chemicals are unnecessary. The pump and its connexions throughout are of steel, and the system is vibrationless and noiseless.

Among other important exhibits in the Metallurgy and Chemistry Departments was an induction furnace in which metals of the highest melting-point can be readily melted by the agency of eddy currents induced in them from a surrounding high-frequency current. Models illustrating the internal constitution of alloys consisting of three or four metals were also shown, together with a number of interesting microphotographs showing the structure of copper containing oxygen and the deformation of metals under the action of cutting tools.

In the Optics Division various forms of apparatus used in colorimetric work were on view, together with demonstrations of the methods used in determining the optical constants of lenses, prisms, optical glass, and the performances of optical instruments. An interesting and simple shadow method of showing up striæ and lack of homogeneity in glass was shown.

In the Electrical Standards Division various methods of measurement of electrical properties at radio- and audio-frequencies were demonstrated.

River-terraces and Glacial Episodes.

A. PENCK'S view, that the infilling of valleys with glacial detritus in Central Europe indicates an ice-extension, while the subsequent erosion of the deposits indicates an ice-retreat and therefore an interglacial episode, has received wide acceptance, and has been applied to areas where other causes may have brought about the facts observed. A. Heim in Switzerland has kept in view the effect of general movements of elevation or depression on river-erosion and valley-choking respectively, and teachers in the British Isles are not likely to have omitted such factors from their explorations of existing features in the homelands. W. Soergel, on the other hand (see NATURE, vol. 108, p. 464, 1921) has felt that the infilling of the valleys round the Rhine-vale and the subsequent erosion must be due to climatic changes rather than to earth-movement, and that much of the infilling is due to frost-action.

There seems to be a feeling in Holland that valley-terraces and "drift" accumulations in the northern lowlands have been unduly linked up with those of the Alpine area, and Prof. J. van Baren has issued a critical paper in English, bearing the long but expressive title, "On the correlation between the fluvial deposits of the Lower-Rhine and the Lower-Meuse in the Netherlands and the glacial phenomena in the Alps and Scandinavia" (Mededeelingen van de Landbouwhoogeschool, 1922; Wageningen: H. Veenman, 1922; price f. 2.50). He lays stress on changes in the position of the sea-level and on tectonic movements generally, and even ascribes to the latter many cases of disturbance in deposits that have been regarded as glacial and as pressed on by the Scandinavian ice-front. In his desire to be free from the incubus of glaciers in the central and northern Rhine-vale, he reverts (p. 13) to the old suggestion that rock-surfaces may be striated by the sliding of stones down mountain-slopes. There is a good deal in recent Dutch discussions of the subject that van Baren desires to make more widely known, and a good deal that will seem to be a challenge to British workers, who have felt that sound conclusions have been reached in regard to the problems of the East Anglian "drifts." The author's beautiful photographic illustrations show how much may be done with the unpromising materials of modern clay-pits.

Dr. C. H. Oostingh (Ber. Oberhess. Gesell. für Natur u. Heilkunde zu Gieszen, vol. 8, 1922) treats of the "Geschrebe südhicher Herkunft in Holland und den benachbartein Gegenden," and, like van Baren, is opposed to the suggestion of any glaciation by land-ice of the hills about the central Rhine. He regards the blocks from the south, of which he has made careful collections throughout Holland, and which are very often angular, as transported by ground-ice floating down the rivers. He asks also for more complete petrographic information as to the materials in the English Forest Bed that have been attributed to the denudation of Germany and the Ardennes. His extensive bibliography will aid numerous English workers in this field.

University and Educational Intelligence.

BIRMINGHAM.—At a degree congregation held on July 7, the Vice-Chancellor (Sir Gilbert Barling) conferred the honorary degree of Doctor of Laws on Dr. F. W. Aston, in recognition of his distinguished contributions to scientific knowledge.

The degree of D.Sc. was conferred (*in absentia*) on Mr. C. S. Fox for a thesis on "The Bauxite Deposits of India," and other papers on geological subjects. The degree of M.D. was conferred on the following:—J. C. Brash, C. C. Elliott, R. J. Gittens, A. P. Thomson, and G. H. Wilson. There were 26 successful candidates for the degree of M.Sc., 94 for the honours B.Sc., 68 for the ordinary B.Sc., and 29 for the degrees M.B., Ch.B.

BRISTOL.—Prof. J. W. McBain is to give a dedication address in connexion with the opening of the Chemical Laboratory at Brown University, Rhode Island, United States.

The degree of Bachelor of Agriculture (B.Agr.) has been established in the Faculty of Science. The curriculum for the degree occupies 5 years, two of which will be spent in the University (including the Agricultural and Horticultural Research Station, Long Ashton), two years in the Royal Agricultural College, Cirencester, and the remaining year on a selected farm.

CAMBRIDGE.—Mr. G. C. Steward, fellow of Gonville and Caius College, has been appointed fellow and lecturer in mathematics at Emmanuel College. Mr. A. H. Davenport has been appointed fellow and bursar of Sidney Sussex College.

The Syndicate appointed to consider the regulations for the Jacksonian professorship on the vacancy caused by the death of Sir James Dewar, recommend that it be defined to be a professorship of natural experimental philosophy as relating to physics and chemistry, and suggest that a professor should be appointed whose work would advance the knowledge of chemical physics on the lines of recent physical, atomic, and molecular research. The exact method by which such researches may lead to finding a cure for the gout—one of the prime duties of the professor according to the will of the founder of the chair—may at present be left to the speculations of the curious.

The Chemical Department Syndicate has issued a

report on the extension of the buildings of the Chemical Laboratory, showing an expenditure on buildings and equipment during the last four years of more than 75,000*l*. The annual report of the Observatory Syndicate refers to work on proper motions of stars, by plates exposed through the glass and measured superposed film to film on old plates taken with the Sheepshanks Equatorial 15 to 20 years ago. The chief points of interest in the report of the director of the Solar Physics Observatory are an account of Mr. C. T. R. Wilson's most recent work on β-ray tracks, continued investigation on the distribution of calcium flocculi and prominences on the sun, the preparation and publication of a revised list of unknown lines in celestial spectra, and work on coarse diffraction spectra by crossing a prism and a grating as originally suggested by Prof. Merton.

The Jubilee Celebration of the Cambridge University local lectures was celebrated on July 6-9 by a conference on various aspects of extra-mural teaching.

ST. ANDREWS.—Prof. J. Read, professor of organic chemistry (pure and applied) since 1916 in the University of Sydney, has been appointed to the chair of chemistry and the directorship of the Chemistry Research Laboratory. Prof. Read may be regarded as the founder of the first school of organic chemistry in the Southern Hemisphere.

RESEARCH bureaus have, during the past three or four years, been created by boards of education in many large and some small cities in the United States. Ten years ago there were none of these organisations: now there are upwards of 45. An account of the constitution and functions of a score of them, published last January by the Bureau of Education, Washington, shows that while in every case they collect and digest facts relevant to the problems with which the boards have to deal, they vary widely in importance and scope. Some resemble the cost-accounting department of an industrial concern, others a military intelligence branch, and all have something of the character of the special inquiries and reports department of our own Board of Education. A city in which this kind of development has been most noticeable is Detroit. Here a highly enterprising and influential Department of Instructional Research has been at work since 1914, formulating educational policies to be carried out throughout the city-school system and watching their operation. It works through its own staff-director, three assistants, four regular clerks, from three to twelve extra clerks, and a department of supervision with separate sections for health, English, exact sciences, social sciences, vocational education, and fine arts, and in close association with a department of special education responsible for psychological measurements, assignments to proper classes and direction of education of "atypical" children. A separate Bureau of Statistics and Reference, with five officers and eight clerks, was organised in 1918. At Indianapolis the research department cost in 1921–22 11,500 dollars, and "in dollars and cents has more than paid its way in watching leakages in receipts and expenditures, and in suggesting more efficient methods of doing things with smaller expenditures."

THE West Indian Agricultural College in Trinidad, which was opened on October 16, 1922, by Sir Samuel Wilson, Governor of Trinidad and Tobago, has now nearly completed the first academic year of its existence, and this first year has been one of great promise and encouragement. *Via colendi haud facilis* —the motto chosen for the College—is a very apt one, and it is well that those in authority with regard to Colonial affairs at home have come to regard tropical agriculture as so serious a pursuit that it has been deemed necessary to found a college for the study of tropical agricultural matters. The prospectus for the coming academic year has just been issued, and in addition to containing information as to College regulations and administration, it gives detailed particulars of the various courses of instruction. Arrangements are made for a diploma course which occupies three years and leads up to a diploma in tropical agriculture. Facilities are also afforded for special study by graduates of other universities and colleges who desire to extend their knowledge of subjects pertaining to tropical agriculture, and to undertake investigations into these matters under tropical conditions. Arrangements for a course in sugar technology, which is one of the subjects for the diploma course, are not yet fully completed, but it is proposed to erect a model sugar factory without delay. It is to be hoped that officers trained in British colleges and universities who have been selected to fill agricultural posts in the Colonies will either be sent to Trinidad to take a special course of study before taking up their appointments, or will be given facilities for carrying out special research at the College during one of their periods of leave. If the College can be used for the further training of our Colonial agricultural officers in the manner suggested, very great benefits will accrue to agricultural enterprises throughout the Empire.

THE Imperial Education Conference, opened by the Duke of York on June 25, concluded its sittings on July 6. This is the second conference officially convened, the first having been held in 1911. A previous conference, held in 1907, was organised by the League of Empire. The current conference was fully representative of education within the Empire in its official aspects. The Irish Free State and Northern Ireland were represented for the first time. The subjects discussed included the qualifications of teachers and mutual recognition of teachers' training and service throughout the Empire, vocational training, leaving certificates, rural education, the bi-lingual problem, native education, and various administrative questions. On the question of school examinations, Dr. H. Murray, of Nova Scotia, made the important suggestion that certificates should state the subjects taken and the percentage of marks gained in each subject, the several universities being left to determine whether or to what extent each certificate should be accepted for matriculation. He thought that, except in special subjects, the value for the Dominions and India of external examinations conducted by examining bodies in Great Britain was apt to be overrated. Mr. W. T. McCoy, of South Australia, urged the establishment of a Bureau of Education for the Empire. He acknowledged the excellent work done by the Department of Special Inquiries of the English Board of Education, but pointed out that there was no book or authoritative publication which supplied information and statistics of education in the Empire in a handy form. To the maintenance of such a Bureau, he suggested, all the dominions, colonies, and dependencies should contribute. In the evenings addresses were given followed by discussion, the most important being by Sir Robert Baden-Powell on character training and a brilliant address by Sir Charles Lucas on "The Island and the Empire." An educational exhibition was organised in the Home Office Industrial Museum and Westminster Training College, which was opened by Mr. Wood, president of the Board of Education. Hospitality was lavishly provided for the delegates, including a dinner given by the Government, under the presidency of Mr. Wood.

Societies and Academies.

LONDON.

The Royal Statistical Society, May 19.—A. L. **Bowley**: Death-rates, density, population and housing. The death-rates and infant mortality rates in the urban districts of England in the years 1911–13 were examined with a view of testing their relationship to the crowding of town populations. In Greater London, for example, the death-rate in districts where on the average there were 100 people to 100 rooms tended to be 12·7; where there were 110 people to 100 rooms 13·9, and so on in arithmetical progression. Six regions were considered separately, namely, Greater London, South of England, Lancashire and the West Riding, North-eastern coal district, Birmingham and South Staffordshire, and the North of England. In the North, generally speaking, the death-rates were higher and crowding and overcrowding more prevalent than in London and the South.—J. C. **Dunlop**: The misstatement of age in the returns of the census of Scotland. Age-periods, one including ages under 6 and the other ages 17 to 92, were discussed. A considerable amount of error persists, but greatly reduced in quantity—a change at least partly ascribable to an alteration of the wording of the age question in the schedule issued to householders at the census of 1921.

Royal Meteorological Society, May 20.—Dr. C. Chree, president, in the chair.—J. E. **Clark** and I. D. **Margary**: Report on the phenological observations in the British Isles, 1922. An exceptionally cool and sunless summer was experienced after mid-June. Before this a fairly mild winter followed by a cold early spring made fruit blossom late. Heat and sunshine of exceptional intensity signalised the latter part of May and early June, resulting in unusually rapid flower and insect development. Ripening was very late, however, especially in the north and Highlands, much hay being ruined or not cut till late September. The dry October and November enabled southern farmers to get well ahead with ploughing and sowing. The isophene flower chart shows little divergence from the lines giving the 30 years average, on account of the acceleration due to May and June. The migrant records indicate a similar sudden speeding up of their movements. As a consequence of the previous favourable summer and autumn there was a remarkable display of blossom and fair fruit crops despite the untoward summer.—T. G. **Longstaff**: Meteorological notes from the Mt. Everest expedition of 1922. A systematic record of temperature was kept on the outward march, at the base camp at 16,500 feet, and at the various climbing camps. Night temperatures were taken with minimum thermometers exposed to the sky on wooden boxes about one foot above the ground. Day temperatures were taken with sling thermometers. The lowest night temperature experienced on the outward march, April 12 to May 1, was 8° F. on April 13 and 19, at a height of 14,000 ft. The mean reading was 15° F. The lowest night temperature recorded during the expedition was −12° F. on May 27 at Camp III. at a height of 21,000 ft. The notes refer only to April, May, and part of June, and on the northern side of the main Himalayan axis of elevation. Totally different conditions prevail on the southern side, and the change from one to the other is abrupt. On the north side of Mt. Everest the snow-level is put at 20,000 ft., and glaciers descend to 16,500 ft. Owing to extreme dryness, evaporation is very rapid. Above 25,000 ft. snow disappears quickly with melting. Probably the constant high winds greatly assist this phase.

Optical Society, June 14.—Mr. T. Smith, vice-president, in the chair.—S. G. **Starling**: Levels and level bubbles. The factors affecting the efficiency of levels of the bubble form are discussed. Benzol, xylol, chloroform, alcohol, and ether are used in levels; the physical properties of these, and also of petroleum ethers distilled at various ranges of temperature, are given. A new method is described of obtaining calibration curves, by photographing the image of the bubble in a plane mirror, so that the position of the bubble upon the scale is obtained for successive tilts given to the tube. The relations between temperature and width and depth of bubble are obtained, and the results applied to an explanation of the "constant" bubble of Messrs. E. R. Watts and Son, Ltd., which has the same length at all temperatures.—E. W. **Taylor**: The primary and secondary image curves formed by a thin achromatic object glass with the object plane at infinity. The shapes of the primary and secondary image curves formed by a thin simple lens of an object plane at infinity can be readily determined. The image curves in the case of a double object glass of ordinary thickness, and with the inner curves approximately in contact, correspond very closely to those of a simple lens of the same power, and are only very slightly affected by the use of different glasses.—T. F. **Connolly**: A new form of balloon theodolite. The instrument is designed primarily for the observation of drifting balloons where it is desired to follow closely and consecutively the movements of the balloon and to note periodically the time and the simultaneous altitude and azimuth observed. The horizontal and vertical circles are brought together in such a way that a single index serves for reading both. A large field achromatic magnifier is so arranged that a "stand off" view is secured. The usual vernier has been abolished and replaced by a single index. Estimations of the degree intervals are made on each circle to 0·1°.

Geological Society, June 20.—Prof. A. C. Seward, president, in the chair.—K. S. **Sandford**, A. S. **Kennard**, B. B. **Woodward**, and R. C. **Spiller**: The river-gravels of the Oxford district. Ancient river-terraces occur in the headwater region of the Thames basin, west of the Chilterns, and maintain the same curve as the thalweg of the present rivers with which they are associated. There is no discontinuity of the terraces of the headwater tributaries of the Thames at their confluences near Oxford. Three terraces are identified above the present flood-plain. Below the lowest are flood-plain gravels, and a sunk channel has been identified. Each terrace contains a warm-climate fauna, with *Elephas antiquus*. The Proboscidea are represented by a suite of forms, from *Elephas antiquus* of archaic characters to the Siberian mammoth. The warm-climate fauna lingers long in the area. Palæolithic implements are scarce; unabraded specimens are of Acheulean culture.—L. **Dollo** and P. T. **de Chardin**: The deposits of Palæocene mammalia in Belgium. The four known deposits in Belgium at Erquelinnes (Hainaut), Orsmael (Brabant), Leval (Hainaut), and Vinalmont (Liège), containing Palæocene mammalia, are of Sparnacian age (=Upper Landenian). They have yielded remains of marsupials, Insectivora, Carnivora, rodents, Condylarthra, Amblypoda, perissodactyls, and primates. No remains of Thanetian mammalia have been discovered in Belgium, and therefore the continuance into the Sparnacian of Belgium of the genus Adapisorex recorded from the Thanetian of Cernay is noteworthy.

Paris.

Academy of Sciences, June 18.—M. Guillaume Bigourdan in the chair.—M. **Mesnager**: An indefinite thin plate, uniformly loaded, supported by points regularly spaced.—Marcel **Brillouin**: The possibility of studying the phenomena of radiotelegraphy on reduced models. A model constructed on the scale of one-thousandth could be made to serve many useful purposes. The modifications necessary to secure similitude are discussed.—P. **Sergesco**: Symmetrisable nuclei.—Serge **Bernstein**: The extremal properties of polynomials and of integral functions on a real axis.—Bertrand **Gambier**: Minimal curves: curves of constant torsion: Bertrand curves. The deformation of the paraboloid and hyperboloid of revolution.—A. **Petot**: The mode of working of automobile brakes.—Etienne **Œhmichen**: The flights carried out at Valentigney (Doubs), on April 28 and May 1, 1923, on the helicopter "Œhmichen-Peugeot, No. 2." A detailed account of two flights with this machine.—Max **Morand**: The electromagnetic radiation of electrified particles.—L. **Fraichet**: The magnetic testing of steels under traction. Elastic limits. The variations in the magnetic state of a steel under varying load show a permanent molecular change at a point named by the author "the true elastic limit." This point is lower than that corresponding to a permanent extension of the bar; the ratio between the "true elastic limit," thus defined, and the limit of proportionality is 0·7 to 0·95 for ordinary steels after annealing, and 0·5 to 0·65 in ordinary steels after tempering.—Paul **Woog**: Some phenomena of the superficial alteration of glass, capable of detection by high-tension currents. The phenomena described depend upon the presence of a layer of sodium carbonate on the glass and its absorption of traces of water from oil, resulting in changes of electrical conductivity.—Léon **Guillet** and Marcel **Ballay**: The influence of cold hardening on the resistance of metals and alloys. The changes in the electrical resistance of metals produced by cold hardening are less than 4 per cent. All the pure metals examined (except lead and tin) showed increased resistance. A brass (68/32) showed a 21 per cent. increase of resistance. In all cases, annealing restores the original resistance.—A. **Dauvillier**: Paramagnetism and the structure of the atom.—P. **Job**: The complex ions formed by silver salts and ammonia or the substituted ammonias. The equilibrium constant of this reaction has been studied by measuring the potential differences between a silver electrode and two solutions containing silver nitrate and silver nitrate plus amine at varying temperatures. Results are given for ammonia, diethylamine, ethylenediamine, and hexamethylenetetramine.—Marcus **Brutzkus**: Contribution to the theory of internal combustion motors.—L. **Hackspill** and A. **Conder**: In the ordinary method of manufacturing liquid carbon dioxide, the gases from the combustion of coke are absorbed by cold potassium carbonate solution, and the pure carbon dioxide required for compression recovered by heating the potassium bicarbonate solution thus obtained. Investigation of a case of rapid corrosion of the condenser of a compression plant showed that ferric nitrate was being produced. This has been traced to oxides of nitrogen produced during the combustion of the coke. These are fixed by the alkali, but small quantities of nitric oxide can arise from the interaction of carbon dioxide and potassium nitrite, and this is the source of the corrosion.—Max and Michel **Polonovski**: Di-iodomethylates in the eserine series.—Mlle. **Brepson**: The formation of soils in the region of Saulieu (Morvan). In this region the process of soil formation is simple, and is due to the decomposition of the subjacent rock under the influence of atmospheric agents: the action of wind or streams plays only an insignificant rôle.—J. **Barthoux**: Observations relating to the genesis of certain manganiferous deposits.—C. E. **Brazier**: The magnetic agitation at Parc Saint-Maur and at Val-Joyeux, and its relation with solar activity. The variations of the solar activity show no relation with the position of the earth in its orbit, while the magnetic agitation has a clear seasonal variation. For this reason the amplitude of the annual variation of the magnetic agitation is compared with the solar activities, 10-year periods corresponding with definite solar conditions being chosen. This annual variation of amplitude follows fairly well the changes in the solar activity.—Fernand **Obaton**: Experimental researches on the reddening of cherries. The reddening of cherries depends on the temperature, and light has no direct action on the phenomenon: a study of the respiratory coefficient showed that an absorption of oxygen accompanies the reddening process.—A. **Goris**: The chemical composition of *Monotropa Hypopitys*.—Ch. **Kilian**: Coefficients of utilisation and velocity of growth in fungi.—Emile **Haas**: The undulation of fatigue in different regions of the spectrum.—A. **Desgrez**, H. **Bierry**, and F. **Rathery**: The action of insulin on glycæmia and acidosis.—P. **Benoit**: Ovogenesis and segmentation of *Myriothela Coksi*.—L. **Mercier** and R. **Poisson**: A case of accidental parasitism of a Nepa by infusoria.—A. **Policard** and G. **Mangenot**: Cytological researches on the condition of the oil in oleaginous seeds. The ripe seed.—Maxime **Ménard**: Ten cases of pregnancy after treatment of fibroma of the uterus by X-rays.—J. **Chevalier** and Fernand **Mercier**: The pharmacodynamic action of the insecticidal principle of pyrethrum flowers.

Perth (W.A.).

Royal Society of Western Australia, December 12.—Mr. E. de C. Clarke in the chair.—L. **Glauert**: (1) Contributions to the fauna of Western Australia, No. 3. A new species of burrowing crab is described. (2) *Cidaris comptoni*, sp. nov., a cretaceous echinid from Gingin. This is the first fossil sea-urchin to be described from Australian cretaceous formations. Affinities are noted with echinids from the white chalk of England and lower cretaceous beds of N. Africa, Sinai, and India.—R. J. **Tillyard**: The Embioptera or web-spinners of Western Australia. The history of the insects as revealed by Palæozoic fossils is described. The previously recorded *Oligostoma hardyi* and a new species, *O. glauerti*, are discussed.—L. **Glauert**: An annotated list of lizards from Wallal. The list includes one new species.—C. A. **Gardner**: Second contribution to the flora of Western Australia. Eight new species are described, one establishing a new genus and introducing the family Ericaceæ into the West Australian flora.

March 13.—Mr. E. de C. Clarke in the chair.—E. S. **Simpson**: Secondary sulphates and chert in the Nullagine series. In the softer beds of the Nullagine (Keweenawan ?) series, which covers large areas in the north-west of Western Australia, gypsum, epsomite, tamarugite, pickeringite, copiapite, alunite, and jarosite occur as vein fillings, efflorescences or imbedded crystals. Chert is widespread as hill-cappings and waste therefrom. The paragenesis of the minerals is detailed and their origin traced to weathering of pyrite and marcasite concretions which are abundant in the series. New analyses of the minerals are given, also the striking chemical

differences between the ground-waters of the Nullagine area and of the Dry Lake region.—L. **Glauert**: Contributions to the fauna of Western Australia, No. 4. A freshwater isopod, *Phreatoicus palustris*, sp. nov., recently found in the swamps and small lakes near Perth, is described. The animal is closely allied to species found on Mount Kosciusko (5700 ft.) and Baring Tops (5000 ft.) in New South Wales; on Mt. Wellington (3800 ft.), Tasmania; on Dividing Range (2000 ft.), Victoria; on Table Mountain (2000 ft.), S. Africa; and in New Zealand, blind, in wells. Its distribution suggests former land connexion between New Zealand, Australia, and S. Africa.—T. H. **Withers**: An Australian cretaceous cirripede. Additional material from Gingin shows that a barnacle previously described by R. Etheridge, junr., as *Pollicipes* (?) *ginginensis* is a species of Calantica (Scillælepas).

April 10.—Mr. E. de C. Clarke in the chair.—A. D. **Ross** and R. D. **Thompson**: Magnitude observations of the star Beta Ceti obtained since the recent reported outburst. The reported increase in intensity can be explained by the fall into the star of a body of planetary size.—E. O. G. **Shann**: The present position in international exchange. A critical discussion is given of the various schemes to regain stability.

SYDNEY.

Linnean Society of New South Wales, March 28.—Mr. G. A. Waterhouse, president, in the chair.—G. A. **Waterhouse** (annual address): (1) Biological survey of Australia. Attention was directed to the slaughter of Australian marsupials for the sake of their skins, and to the export of enormous numbers of birds. The scientific interest of the fauna is evidenced by the number of collecting expeditions visiting Australia. The protection of the flora is a necessary corollary of any attempt to protect the fauna, and support is given to a recent suggestion to preserve the forests of all those portions of New South Wales which are more than 4000 feet above sea-level. (2) A further account of breeding experiments with the Satyrine genus Tisiphone. An account of the family from an orange female caught at Port Macquarie, April 17, 1922. This female had probably not laid any eggs before her capture, and she laid 14 eggs in captivity, from which 12 butterflies were obtained. The family shows, in the general shape of the forewing markings and the absence of the hindwing band, a closer approximation to *abeona* than to *morrisi*; the colour of three-fourths of the specimens is that of *abeona* rather than *morrisi*, but the size and coloration of the ocelli approximate rather to *morrisi* than *abeona*.

Mr. A. F. Basset Hull, president, in the chair.—R. **Greig-Smith**: The high temperature organism of fermenting tan-bark. Pt. ii. In the process of white-lead manufacture, the spent bark, before being again used, is subjected to a preliminary fermentation in which moulds play a part. Several that were isolated were able to convert cellulose into soluble products capable of being attacked by the high-temperature organism. The tempered bark contains humic acid as a typical constituent, and this substance is fermentable. Tempering is clearly a biological process in which the woody matter of the bark is altered to substances that can be fermented by the high-temperature bacterium.—J. **McLuckie**: Studies in symbiosis. No. 3. A contribution to the morphology and physiology of the root-nodules of *Podocarpus spinulosa* and *P. elata*. The development of the root-nodules of these two species of Podocarpus, the method of infection of the roots by the bacteria, the distribution of the bacteria in the cells, and of the fungal hyphæ which are frequently present, are discussed. The nitrogen-fixing power of the organism causing the nodule formation has been estimated.—G. F. **Hill**: New Termites from Central and South-East Australia. One new species of Coptotermes and two new species of Eutermes are described. The Australian termite fauna now comprises 6 species of Coptotermes and 28 species and 1 variety of Eutermes.—T. G. **Sloane**: Studies in Australian entomology. No. xviii. Synoptic tables of the Australian species of the genera Dyschirius, Craspedophorus, and Dicrochile are given, and a table of genera of the tribe Odacanthini—introducing 2 new genera.

CALCUTTA.

Asiatic Society of Bengal, June 6.—S. L. **Hora**: The adhesive apparatus on the toes of certain geckos and tree-frogs. It appears probable that all such adhesive apparatus consist of mere friction devices.—M. J. **Seth**: A manuscript Koran in classical Armenian.—L. R. **Rau**: On the age of the Uttatur marine transgression. The fossils in the lowermost Uttatur deposits and their correlation with foreign equivalents appear to show that the term "Cenomanian transgression," now generally employed for this encroachment of the sea on land in Southern India during cretaceous times, does not faithfully represent it in point of time and has to be modified so as to accord with an older age.—R. **Chanda**: (1) Note on the discovery of supposed Neolithic writing in India. The inscription on one neolith is evidently a modern date in Arabic numerals. The other object is not a neolithic artifact, and the letters are probably scratches. (2) Prof. Mazumdar on the dates of the Sanchi inscriptions. A fifth test letter, *dha*, for distinguishing post-Mauryan Brahmi.—N. K. **Majumder**: Siddhānta-Sekhara of Sripati. A brief introductory account of an important treatise on Indian astronomy, Siddhānta-Sekhara, by the reputed Indian astronomer, Sripati, of the eleventh century A.D. Recently a copy was discovered in the Trivandrum Palace Library, and a few other copies in the Government Oriental Manuscripts Library of Madras.—C. B. **Kloss**: On Blyth's bulbul (*Xanthixus flavescens*). Specimens from North Cachar are sufficiently different from specimens collected in Arrakan to be accepted as representing a new sub-species.—P. C. **Mahalanobis**: A first study of the head-length of Bengal castes and tribes. A biometrical analysis of the head-length of 36 Bengal castes and tribes.

Official Publications Received.

Records of the Survey of India. Vol. 16 (Supplementary to General Report, 1920-21). Annual Reports of Parties and Offices, 1920-21. Prepared under the direction of Col. C. H. D. Ryder. Pp. iv+140+10 maps. (Dehra Dun: Trigonometrical Survey.) 4 rupees; 8s.

Canada. Department of Mines: Mines Branch. Summary Report of Investigations made by the Mines Branch during the Calendar Year ending December 31, 1921. Pp. 346+20 plates. (Ottawa: F. A. Acland.)

Mellon Institute of Industrial Research of the University of Pittsburgh. Tenth Annual Report on the Industrial Fellowships of Mellon Institute, by Edward R. Weidlein, for the Institute's Fiscal Year, March 1, 1922, to March 1, 1923. Pp. vi+20. (Pittsburgh, Pa.)

Proceedings and Reports of the Belfast Natural History and Philosophical Society for the Session 1921-22. Edited by Arthur Deane. Pp. viii+131. (Belfast.) 5s.

Report of the National Research Council for the Year July 1, 1921, to June 30, 1922. Pp. iv+85. (Washington: Government Printing Office.)

Diary of Societies.

TUESDAY, JULY 17.

ROYAL ANTHROPOLOGICAL INSTITUTE (Special Meeting), at 8.15.—Dr. D. E. Derry: The Discovery of Fossil Human Bones in Egypt, possibly of Pleistocene Age.

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Muscular Exercise.[1]

By Prof. A. V. Hill, F.R.S.

Introduction.—Muscular exercise is a subject in which most people are interested. It is fortunate therefore that, in this direction, physiology has made greater progress into the intimate working of the body than perhaps in any other. The means by which bodily movements are carried out is muscle. Muscle is the red meat. There are three kinds of muscles: the voluntary muscle of the trunk and limbs, governed—or at any rate governable—by the conscious will of the individual; the involuntary muscle of the blood-vessels, of the alimentary and excretory, the so-called vegetative, system; and the cardiac or heart muscle, the muscle which pumps the blood round the body.

Muscle from the microscopic point of view is made up of a large number of similar thin fibres, about $\frac{1}{500}$ inch in diameter, and made of a jelly-like substance, running more or less parallel to one another. They are liberally supplied with minute blood-vessels from which they obtain their supplies of oxygen and food.

The voluntary muscle fibre is long and regular, and has obvious and characteristic cross-striations. The involuntary muscle fibre is smooth and long, with obvious nuclei, and generally occurs in thin sheets. It shows no sign of cross-striations. The heart muscle is vividly cross-striated, but its fibres are shorter and connected physiologically with one another, not running regularly in considerable lengths, their directions corresponding to the lines in which the walls of the heart are required to shorten, in order to expel the blood efficiently.

The voluntary muscle is excited by a voluntary, a so-called medullated nerve: the involuntary muscle by an involuntary, a non-medullated nerve: the heart beats automatically of itself, though its beats can be influenced reflexly through two nerves.

In function the muscles differ very widely from one another. The voluntary muscle moves very rapidly, indeed in some small animals the rapidity of its response is almost incredible—one knows the amazing quickness of a little bird jumping from twig to twig, but this is as nothing compared with the speed with which some small insects move their wings, a speed which one can detect from the high-pitched note they emit. The voluntary muscle is very powerful; it is usually "geared up" to increase the quickness of movement of the limb to which it is attached; if the flexor muscles of the arm of a powerful man were connected directly to a heavy load, they could lift a weight of about half a ton.

The voluntary muscle is very efficient for movements of moderate speed: it is very wasteful, however, if used to maintain a force for a long time, or if required to contract, either very rapidly or very slowly. The involuntary muscle, on the other hand, moves only very slowly: it takes seconds to perform what a voluntary muscle can do in a few tenths or hundredths of a second; it is very economical, however, in maintaining a force for minutes, or hours, for intervals maybe thousands of times longer than would be enough to produce complete fatigue in a voluntary muscle. The heart muscle moves at an intermediate speed: in man from 40 to 200 times a minute, depending on his health and training and state of exercise: in little animals faster, in large animals slower: it beats only—it never maintains a contraction—it would, so to speak, lift a weight up and down, but it could never keep it supported: it is amazingly infatiguable—it has a first call on the oxygen of the blood, and it can perform the most prodigious athletic feats.

A muscle's function is to "contract." The word contraction—drawing together—very well defines the activity of muscle: its volume does not alter when it contracts: like a piece of elastic it merely draws—or attempts to draw—its ends together. The sheaths of the muscle fibres are continued as tendons, and these tendons are attached to bones, so that when the muscle draws together the bones revolve about their common joint, and movements are produced. In heart muscle, the whole organ, in the form of two pumps, with inlet and outlet holes and suitable valves, is simply a closed vessel with powerful contractile walls which—by their drawing together—expel the blood into the arteries and around the body.

The fibres of voluntary muscle are bound together into anatomical and functional bundles—the so-called muscles—doing special duties in special ways and in special distributions. If a muscle be required to move through a long distance its fibres are parallel to the length of the muscle and long: if it be required to

[1] Discourse delivered at the Royal Institution on Friday, February 16.

move only through a short distance, but to exert a more powerful pull, its fibres run partly across the length of the muscle, they are shorter, and there are more of them: length of movement is sacrificed to strength.

Nervous Control.—The muscles have their activities controlled and co-ordinated by the nervous system. Partly this co-ordination is conscious and voluntary; mainly, however, it depends upon involuntary reflex control. In the body, in addition to the ordinary sense-organs is a complex and very important sensory system — the proprioceptive system — which deals mainly, or only, with the position, translation, and rotation of the body, with the stresses and strains in the muscles, with the positions and movements of the limbs. This system keeps the nervous system informed about the movements, passive or active, of the body, and about the strains and stresses, passive or active, of the muscles: and when anything happens, with amazing rapidity and almost unerring accuracy, the appropriate reaction is made, so that the balance or the posture is maintained, the integrity of the body is safeguarded, and the end in view is reached. Efficiency and skill at games, power and economy in violent effort, the faculty, in the literal sense, of falling on one's feet, all depend upon these quick, silent, overmastering, and generally unconscious reactions, dictated by the nervous system on the receipt of urgent messages from tendons, joints and muscles, or from the little sense organs associated with the ear.

Skill, power, and economy of muscular effort depend upon the effectiveness of these reactions; partly this muscular sense can be acquired, partly it is inborn, partly it is conscious or semi-conscious (though always inarticulate), partly it is reflex and instinctive: in any case it represents a highly developed and a very beautiful and important property of the nervous system. The instinctive skill, quickness, and economy of the gymnast or climber, of the mechanic, airman, tennis player, or athlete, depend upon a vivid and readily reproducible picture in the brain or nervous system, *a picture*, as Pear puts it, *of muscular exercise in terms of the sensations which effective and successful movements produce*. This lecture is intended to deal more particularly with quite another aspect of muscular exercise. To stress the energetic side of exercise, however, without any note on its intellectual and co-ordinative side, would give quite a false impression of the interest and variety of the subject.

Energetics.—Let us turn now to what one may call the energetics of muscular activity, of the capacity for doing work, or producing movement, of the cost of that work—of what we call "efficiency"—and of the conditions which limit that capacity—of what we call "fatigue." When a muscle contracts it can do work, which can be measured in gm. cm., or in ft. lb. This capacity for doing work seemed to physiologists to be the primary thing, until it was realised comparatively lately that *force*, rather than *work*, is the fundamental product of muscle. To maintain a state of contraction—even when no work in the mechanical sense is being done, as, for example, in pushing an immovable object, or in holding a weight at a fixed level—is just as tiring and expensive as actually to do mechanical work. The function of a muscle, therefore, is to pass from one state of stress to another state of stress without necessarily altering its length at all: if its load, or the resistance to its motion, be such that the muscle can shorten when its tension rises, it will of course do work in the mechanical sense: if, however, it maintain its state of tension without shortening at all, it will, none the less, require energy and become fatigued. Indeed, one knows that the most fatiguing exercise is to hold something, say at arm's length, without moving it up or down, without therefore doing any work at all in the mechanical sense.

Isolated Muscle. — Fortunately, for physiology, muscles can be isolated, and made to continue their function of contracting for days after removal from the body. It is easy to keep a frog's isolated muscle alive, in the sense at any rate that it will react to a stimulus, for many days. Moreover, the chief function of a muscle, indeed in a cold-blooded animal the only function, is simple and easy to detect and measure: the function of movement, of maintaining a posture, of exerting a force, is so extremely important to the animal that a very large proportion of its body has been devoted to this single highly differentiated purpose. Fortunately also it is easy to apply an artificial stimulus to a muscle, the electric shock, which produces no injurious effects and leaves the muscle ready to react again in a similar way a large number of times. A single sharp burst of electric current excites the muscle fibre to give the simplest and most fundamental unit of physiological response, the muscle twitch. In a twitch the tension rises, attains a maximum, and then falls again to zero, the whole cycle occupying anything from a small fraction of a second up to several seconds, depending upon the nature and condition of the muscle.

Now, in a voluntary muscle it is often—indeed almost always—necessary to maintain a force, or to exert a pull, for a finite and determinate time, not simply to give a tug and have done: and in such muscle this continuous pull can be produced by a rapid succession of stimuli each occurring before the effect of the previous one has passed off. One's own muscles do not appear to be obviously unsteady when exerting a voluntary effort: it can easily be shown,

however, by a delicate electrical device that 40 to 50 obvious vibrations per second occur in them, and that they are really reacting discontinuously to a rapid stream of stimuli: even the shortest voluntary contraction of which the human muscles are capable is due to a volley of impulses shot at it, along the nerves, by the brain. Each separate unit of effort, however, which goes to make up the complete contraction is expensive—each requires energy just as each stroke with a pump requires energy. It is obvious, therefore, why the *maintenance* of contraction is expensive and fatiguing.

Fatigue.—Nearly all the recent and important advances in muscle physiology have resulted from a study of the phenomena of fatigue. We all know that there is a limit to muscular exertion, a limit which is set by what we call fatigue. If an able-bodied man take exercise at a very small rate, *e.g.* by walking, he remains comparatively untired for long periods: if he takes exercise more violently he becomes tired more quickly: if he exerts himself with the extreme effort of which he is capable, he is completely exhausted in less than a minute. There are many different kinds of fatigue, but the one we are discussing now, from the study of which so much light has been shed on the nature of muscles, is the extreme athletic fatigue which results rapidly from very violent effort. By it the finest athlete in the world may be overcome within a minute. It is a simple and comparatively intelligible thing. We can reproduce it readily in isolated muscle, deprived of its circulation. Let us subject an isolated frog's muscle, every second or two, to an electric shock, and record its contraction · we find that the response changes in a regular and progressive way, the force exerted becoming less, the contraction being developed rather more slowly and continuing much longer, relaxation being much drawn out. Finally, the muscle becomes inexcitable. Now in the intact animal, in man, we know that even extreme fatigue is rapidly recovered from, and this recovery is attributed to the circulation. If the circulation be hindered by a cramped position recovery is slower. If the fatigued isolated muscle be left in a chamber free of oxygen, no sign of recovery occurs: if, however, it be left in oxygen, in a few hours complete recovery will take place, and the muscle will now be capable of repeating its previous effort.

The realisation, especially by Fletcher about twenty-five years ago, of the extreme importance of this observation led directly to the most striking advances in our knowledge of the working of muscle. Recovery from fatigue is possible only in the presence of oxygen, and it was natural to suppose that the oxygen was used to oxidise some waste product, the presence of which acted unfavourably on the muscle. The next great step was due again in part to Fletcher, this time in co-operation with Hopkins. Lactic acid was known to occur in muscle, and Fletcher and Hopkins found the lactic acid to be increased by exercise, and diminished or abolished by recovery in the presence of oxygen. Furthermore, there appeared to be a certain definite maximum, beyond which the lactic acid content of the muscle could not be driven, even by the most vigorous stimulation: clearly this corresponded to the maximum effort a muscle could make. What was the function of this lactic acid, was it indeed to be the keystone of the bridge which physiologists were building from physics and chemistry on one hand to muscular activity on the other?

Heat-production.—Muscles, in activity, give out heat. External mechanical work is produced by the muscle with an efficiency of only about 25 per cent. Hence for every 25 ft. lb. of energy turned into external mechanical work at least 75 ft. lb. are degraded into heat inside the body. In a maintained contraction, in which no actual work is done, all the energy used is turned into heat: while in such movements as running, the energy is indeed turned in part into kinetic energy, which, however, is chiefly reabsorbed into the body as heat, owing to the jolts and jerks and rapid movements of the limbs, just as the energy of a motor car on a bumpy road is absorbed largely as heat in the tyres. In a single muscle twitch the rise of temperature is only about 0·003° C., and if one wishes to measure to 1 per cent.—and for some purposes one must measure to 0·1 per cent.—it is necessary to read to the nearest 0·00003° C. This can, however, be done, and with the wonderful electrical measuring instruments now available it has become comparatively easy. It is worth doing, because the heat accompanies, and is a measure of, the chemical processes occurring in muscular activity, and its production can be followed continuously, and so made to give us the time course of those chemical processes.

If the electrical record of the thermal response of the muscle to stimulation be carefully analysed, it is found that the heat-production is by no means simple in its time relations. In the first place, if the muscle be in oxygen, there is an evolution of heat lasting for many minutes after the contraction is over: and this evolution of heat is not small, but actually larger in total extent than the heat which occurs early in the contraction. In the absence of oxygen this delayed heat almost disappears. Clearly it is somehow connected with the recovery process Fletcher had noticed in an exhausted muscle, which we all know in our own bodies; it is accompanied, as Fletcher and Hopkins had shown, by a disappearance of lactic acid. The recovery heat-production occurs more

rapidly at a higher pressure of oxygen. This agrees with what we know of recovery from exertion, or exhaustion, in man: breathing pure oxygen, instead of air, enormously increases its speed and completeness. Moreover, the magnitude of the recovery heat-production told one what happened to the lactic acid in recovery. One knew how much lactic acid was produced in a given contraction; one knew, therefore, how much lactic acid was removed in the complete recovery from that contraction: if it were all oxidised the heat evolved could be calculated: actually the amount observed is only about 1/6th of the amount calculated: hence the lactic acid removed in recovery, or at any rate its chief part, is not removed by oxidation, but in some other way.

Apart from this delayed heat-production associated with recovery, one might have expected the rest of the heat to be given out rapidly, more or less ex-

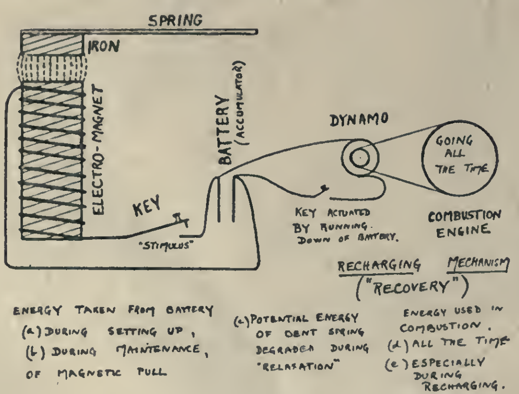

Fig. 1.—Electromagnetic analogy to the working of muscle.

plosively, at the commencement of contraction. Contraction has been likened to the explosion of a cartridge: the muscle suddenly gives out heat and develops force. This force, however, represents a state of elastic potential energy in the muscle, and when the muscle relaxes this potential energy disappears, and we should expect it to reappear as heat. Actually the analysis of the heat-production in the single twitch shows that about 60 per cent. of it is evolved in the initial process of setting up the contraction, 40 per cent. of it in the final stage of relaxation. If the contraction be prolonged, there is in addition a prolonged evolution of heat, lasting as long as the contraction, the rate of heat-production being proportional to the force maintained.

There are, therefore, four phases in the heat-production of muscle, corresponding (1) to the development, (2) to the maintenance, and (3) to the disappearance of the response, and finally (4) to recovery therefrom. A simple physical picture of the system is given (Fig. 1) by an electromagnet, pulling on a piece of iron attached to a spring: a key: a battery: and a dynamo (driven by a combustion engine of some kind) to recharge the latter. Energy is consumed in setting up the pull of the electromagnet, energy is being consumed all the time in maintaining the pull, energy—the potential energy of the magnetic field and the spring—is liberated when the current is broken, and energy is used in recharging the battery.

This picture has recently been given a more concrete chemical form. In contraction the lactic acid comes from glycogen; in recovery the lactic acid is restored as the glycogen from which it came, apart from a small proportion—about $\frac{1}{6}$th—which is oxidised to provide energy for the restoration. In the setting up of the contraction, therefore, lactic acid is liberated; in relaxation it is neutralised: it somehow produces the mechanical response by the action of its acidic part upon the structural protein elements of the muscle fibre. Protein is a weak acid at the hydrogen ion concentration of the body, and the structural elements of the muscle are in effect highly ionised sodium (or potassium) salts of protein. These structures therefore have a negative electric charge, all along their length, each element of the structure repelling every other element. The localised production of lactic acid causes the formation of sodium (or potassium) lactate, and of undissociated protein acid: the protein structure is discharged electrically: its elements cease to repel each other, and shortening occurs. It is well known that if the surface charge of mercury, in contact with sulphuric acid, be changed by conduction from outside, there results a change of surface tension, and so a movement of the mercury. This principle is utilised in the capillary electrometer, and would seem to have been employed by Nature in the muscle. The heat associated with contraction is due to the chemical formation of lactic acid from glycogen. As soon, however, as the lactic acid is free it is neutralised by the alkalies of the muscle, and relaxation sets in, the heat produced in relaxation being due to the chemical process of neutralisation. To maintain a contraction therefore requires a balance between the rate at which lactic acid is produced and the rate at which it is neutralised. Finally, in recovery, the neutralised lactic acid is slowly removed and restored, by the working of some unknown recovery mechanism, by which 5 parts of it are restored, and 1 part oxidised to supply the necessary energy.

Exercise in Man.—Our knowledge of the nature of muscular work in man has been derived largely from a study of the amount of oxygen used, and the various characteristics and time-relations of the oxygen supply. The subject of the experiment carries a large bag on his back (Fig. 2) and by means of a mouthpiece containing two valves, and a pipe and tap, he can breathe

in fresh air from the outside atmosphere and expire it all automatically into the bag. A sample of the expired air can be collected for any desired interval. An analysis of it, a measurement of its volume, and a knowledge of the composition of the inspired air, allow a determination of the oxygen taken in and the carbon dioxide produced. From these the amount of energy used by the man during the period in question can be calculated. A point immediately brought out is (as in the isolated muscle) that the oxygen must be regarded, not as being used during the actual exercise itself, but in recovery, each element of the oxygen consumption corresponding to recovery from a previous element of the exercise (Fig. 3).

FIG. 2.—Bag, pipe, tap, valves, and mouthpiece used to investigate the gaseous exchanges of man during running.

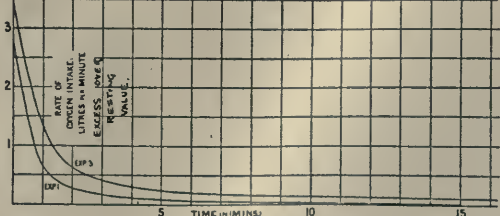

FIG. 3.—Oxygen intake in recovery after exercise: exercise ends at time o.

Many kinds of exercise have been investigated, for example bicycling, swimming, climbing, walking, running, ski-ing, and skating, and even the laborious process of pushing a motor bicycle up a hill! The two main types of muscular exercise are: (*a*) very violent exercise lasting for a short time, and (*b*) prolonged exercise of a more moderate kind.

Violent Exercise.—Let us take first the case of very severe exercise, for example, that of a man running 100 yards at top speed. The first personal impression which one forms of such severe exercise is that immediately after it, and often for a comparatively long time after it, panting occurs. The oxygen taken in is used almost entirely in recovery. In one experiment a good runner ran 225 yards in $23\frac{2}{5}$ seconds, and in the succeeding quarter of an hour recovered from his effort and used an extra $8\frac{3}{4}$ litres of oxygen in so doing. Such exercise, if it *could* be continued indefinitely, would require about 22 litres of oxygen every minute, but from other experiments the subject is known to be incapable of taking in more than about 4 litres per minute. Hence, during the most violent effort of which he was capable, he was using energy at about $5\frac{1}{2}$ times the rate that would have been possible had it been necessary for him to depend upon a contemporary supply of oxygen.

The "record" is held by a man of 46, who by means of a rapid quarter-of-a-mile run, followed by violent gymnastic exercise for 30 seconds, succeeded in making himself so exhausted that $13\frac{1}{2}$ litres of oxygen had to be used in recovery. This amount of oxygen would have maintained him quietly in bed for about an hour! It is clear that the body can get energy "on credit," which it has to repay after the exercise is over, by taking in later an extra amount of oxygen. It acts in the same manner as an accumulator, which can be run down at a very high rate for a short time and recharged afterwards. The discharge process is the formation of lactic acid from glycogen: in recovery this is reversed, the energy for the reversal being provided by combustion. The maximum lactic acid production in the muscle determines the limits of exercise, and the magnitude of the "maximum oxygen debt."

Prolonged Exercise.—Let us now discuss the case of exercise continued for a long time. By the most extreme effort of the respiratory system, a healthy man can take in about 4 litres of oxygen every minute. Consider, then, the case of a man taking exercise for a long time, say for an hour, during which time he will take in and use anything from 150 to 240 litres of oxygen. An oxygen "credit" even of $13\frac{1}{2}$ litres is only a small fraction of the oxygen which he can actually take in during the hour of exercise. Hence, he is limited in such types of exercise, not by the magnitude of the "debt" to which the body can submit, not, that is to say, by the lactic acid maximum of his muscles, but chiefly by the maximum rate at which he can take in oxygen. The oxygen is brought to the

lungs by the movements of respiration, thence diffuses through the lungs into the blood, which is pumped round the body to the active limbs and muscles. The amount of oxygen, however, which can be carried by the blood is comparatively small, namely, only about $\frac{1}{8}$th of its total volume.

The efficiency of the mechanism by which the oxygen is carried round in the circulating blood depends very largely on the efficiency and capacity of the heart. For prolonged vigorous exercise a powerful and efficient heart is essential. If, however, the lungs be too small the oxygen pressure in them will fall too rapidly when a given amount of oxygen is carried away by the blood, and the smaller the lungs the shorter will be the time (for a given blood-flow) during which each drop of blood lingers in them in contact with the air. The smaller the lungs, therefore, the less opportunity will the blood have of collecting its required oxygen: the smaller the lungs and the less efficient their ventilation, the lower will be the pressure of oxygen in the arterial blood.

Now the heart is an extremely vigorous and hard-working organ, and it has the first call upon the oxygen which is carried by the blood. The coronary artery takes blood directly from the aorta, and carries it round the heart muscle itself. If the lungs be small, or their ventilation inadequate, or their walls too impermeable, the pressure of oxygen in the arterial blood will begin to fall; consequently the heart itself will get a lower pressure of oxygen—it will slow up or give a less effective beat, the blood-flow will be slowed, and the oxygen pressure in the blood will rise again to another higher value. Thus a balance will be reached in which each unit in the double mechanism is working at its limiting capacity, and one will find in athletes, who are capable of long-continued effort, that there is a combination of (*a*) a vigorous and efficient heart, and (*b*) capacious lungs capable of rapid and extensive ventilation.

A vigorous output of blood by the heart requires a vigorous return of blood to the heart. On the venous side of the small capillaries which feed the muscles with oxygen, there is little pressure left to drive the blood along to the heart. In the veins, therefore, the flow of blood is largely determined by the activity and movements of the body. The veins are provided with valves, and the alternating movements of the limbs and muscles help to pump the blood along the veins. If the body be rigid the arteries and capillaries are constrained and the blood-flow is hindered, while the veins get none of the rhythmic changes of pressure which tend to pump the blood along them, and so they fail to supply the heart with blood. Such exercise as holding oneself up with arms bent, in a gymnasium, on a pair of rings, is not in itself violent, and would not, if it *could* be continued, require an amount of oxygen comparable with running, even at so slow a pace as eight miles an hour. In such exercise, however, an extremely violent contraction in the very muscle that requires the energy almost entirely prevents the supply of blood to it, no oxygen is received, lactic acid rapidly accumulates, and exhaustion sets in.

Similarly, in such types as rowing, in which part of the body is in a state of stress during a large part of the time and the rhythmic movements are relatively slow, the supply of oxygen is more difficult. Consequently rowing appears to strain the heart more often than other kinds of athletic effort. For an easy and vigorous circulation no exercise seems to compare with running on the flat; here the movements are very rapid and the muscles are rigid during only a fraction of each cycle; consequently the blood can run through very easily, and it gets helped along in the veins by the jolts and jerks and shakes which the body receives, and by the rapid rhythmic pressures which are applied to the veins by the movements of the limbs. Thus from the point of view of taking as much exercise in a given time, with as little strain on the heart as possible, running is probably superior in type to any kind of exercise.

The function of the heart in exercise is so important that a vivid appreciation is desirable of the extraordinary tasks it sometimes undertakes. A subject of $11\frac{1}{2}$ stone weight succeeded in taking in about 4·2 litres of oxygen in a minute, while running round a track at about 9 miles per hour carrying a bag and breathing through valves and mouth-piece. Now the amount of oxygen which the blood can take in and give out, as it circulates once through the body, is certainly not more than about $\frac{1}{7}$th of its own volume. Hence at least 7 times 4·2 litres of blood per minute, *i.e.* about 30 litres, were circulating round his body during this experiment. The largest water-tap in an ordinary house has an output which is poor when compared with that of a human heart. It is little wonder that the heart goes wrong sometimes: the wonder is that this happens relatively so seldom.

An Example from Athletics.—The way in which the capacity of the body for exercise depends upon the supply of oxygen, actual or potential, can be illustrated by an example from athletics. A certain subject is capable of taking in about 4·2 litres of oxygen per minute; let us assume that his maximum oxygen credit is 13·2 litres, as found by Lupton in another subject. Suppose that at the end of a race his oxygen supply, actual or potential, is completely exhausted. Then clearly if he runs for a minute he has $(4{\cdot}2+13{\cdot}2)=17{\cdot}4$ litres to spend altogether: if he runs for two minutes $(2\times4{\cdot}2+13{\cdot}2)=21{\cdot}6$ litres altogether, or 10·8

litres per minute: if for five minutes, 34·2 litres altogether, or 6·8 litres per minute. The reason why he can run faster in a short race than in a long one is that his average rate of expenditure of oxygen can be higher. Now the following table gives the best performances, at various flat distances, of this subject, together with calculations therefrom, on the above assumptions:

Distance.	¼ mile.	⅓ mile.	½ mile.	1 mile.	2 miles.
Time	53 sec.	1 m. 17 s.	2 m. 3 s.	4 m. 45 s.	10 m. 30 s.
Average speed, metres per min.	455	419	392	339	306
Oxygen available in this time (lit.)	17	18·6	21·8	33·1	57·3
Oxygen requirement per min. at this speed (lit.)	19·2	14·5	10·6	7·0	5·5

If, therefore, the maximum rate at which a fit man can run a given distance does depend only upon the amount of oxygen he can obtain (*a*) out of income

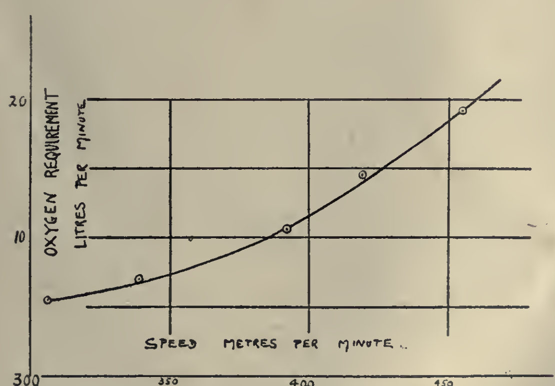

Fig. 4.—Oxygen requirement per minute for running at different speeds: *calculated* from the data in the previous Table.

through the lungs and circulation, and (*b*) on credit, then, knowing the maximum intake and the maximum credit, one can calculate the requirement at the different speeds. Running at 306 metres per minute, apparently about 5·5 litres of oxygen per minute were required; at high speeds much more; at the highest speeds enormously more (Fig. 4).

It is instructive therefore to inquire, by direct experiment, whether the oxygen requirement of running really has the value we have calculated, whether it really rises so rapidly as the speed of running is increased. The oxygen can be measured as before. It is necessary to take into account not only the oxygen actually taken in, but also the increase in the oxygen debt during the period of running. The subject stands at rest and measures his resting oxygen consumption; he runs 100 yards at the required speed; during the run and in the following fifteen minutes his oxygen intake is measured; from this is subtracted the oxygen he would have used had he remained at rest the whole time; the remainder is the oxygen consumption due to the exercise, during and in complete recovery from it. The result is exactly as shown in the figure: the measured oxygen requirement rises continuously as the speed is increased, attaining enormous values at the highest speeds. Hence we may conclude that the maximum time for which an effort of given severity can be maintained is determined mainly by considerations of the oxygen supply, actual or potential, to the active muscles.

Economy of Movement.—This leads us to the important practical question of what is called the "efficiency" of movement. Clearly if a given movement can be carried out more economically, *i.e.* at the expense of less energy, then less oxygen will be required for it, and its maximum duration can be increased. It seems probable that the difference between a good long-distance runner and a bad one may often be due, not to the fact that the good runner has a more effective mechanism for supplying his muscles with oxygen, but rather to the fact that he carries out his movements with greater economy. In any category of muscular effort the unpractised person will use inappropriate muscles and movements, or will use the appropriate muscles with an inappropriate force or rhythm. Some people's nervous systems are naturally athletic: the pictures they form of muscular movement, in terms of the sensations which it gives them, are clear, vivid, and sharp: they realise easily, from its subjective aspects, the most economical, the most effective, and the most convenient manner in which to employ and co-ordinate their various muscles, both in the power, the phase, and the rhythm of their several responses. Other people are clumsy, ineffective, and uneconomical.

If the timing of the valves of a motor, or the timing of the spark, be wrong, or if the valve clearance be not correct, the efficiency drops; so it is in an animal: if the muscles do not react with one another in the right phase, with exactly the requisite force, and in the appropriate rhythm, the movement becomes uneconomical. This economy of effort can, in part, be taught: but just as all the practice in the world will not turn some quite intelligent people into mathematicians, so all the practice in the world may never turn some quite powerful and well-developed people into first-class athletes. Training and practice are essential, but they can only build on an aptitude already there. If a subject use his muscles uneconomically, if—so to speak—the timing and clearance of his valves be wrong, he will need an excessive supply of oxygen. Consequently he will be an ineffective athlete, or an ineffective workman: he is uneconomical. Athletic

prowess depends not only upon a large oxygen supply, but upon a low oxygen requirement.

Mechanical Efficiency.—Finally, let us consider the "mechanical efficiency" of muscular movement in its more technical sense, of work done divided by energy utilised in doing it. The mechanical efficiency of a steam engine may be from 5 per cent. to 20 per cent.: of a gas engine it may be higher, say up to 30 per cent. In man, the mechanical efficiency of muscular movement may be as high as 25 per cent.; the remaining 75 per cent. loss of energy is a serious thing: to what is it due? It seemed, from the purely physico-chemical point of view, that an efficiency of 100 per cent. was conceivable: the free energy of the oxidation of food-stuffs is very large. We know, however, that the body has been organised so that it can go on for a while without sufficient oxygen; it is like an accumulator: it can be discharged and then recharged: it can run into debt for oxygen, and pay off its debt afterwards.

If an animal like man were forced to live within his "oxygen-income," and were able only to make efforts which were possible on his contemporary oxygen supply, he would be a very feeble creature: only about $\frac{1}{4}$th as energetic (for short-lived effort) as he actually is. Moreover, oxidation in the body is a very slow thing; it takes minutes to complete, and it would be a disadvantage to take three minutes over every muscular movement. Hence the mechanism of the muscle has been evolved and differentiated on a different plan: oxidation is not the chemical reaction which directly and immediately provides the mechanical energy of the muscle: the actual process which produces the mechanical energy appears to be some kind of explosive transformation of a glucose di-phosphoric ester into lactic acid, and the subsequent physical or physico-chemical reaction of this lactic acid with the protein structures of the muscle. In recovery the lactic acid is restored, about $\frac{5}{6}$th of it, to the precursor from which it came, the remaining $\frac{1}{6}$th (or its equivalent amount of glycogen) being oxidised to provide the energy for the reversal. Mechanical energy is liberated only in the first stage, which appears to have a very high "efficiency"—probably about 100 per cent. In the recovery stage, however, 150 units of heat are liberated by oxidation for every 100 units in the initial stage, and this reduces the efficiency of the whole cycle to about 100/250, *i.e.* to about 40 per cent. Apparently, therefore, a big reduction in efficiency is effected simply by taking proper account of the recovery process, and is due to the need the animal often experiences of taking violent exercise, so to speak, "on credit."

Even so, however, 40 per cent is far higher than the efficiency actually found in man: the remaining reduction of efficiency is due to two other factors: (*a*) to the rapidity of the usual type of muscular movement, and to consequent frictional loss inside the muscle; and (*b*) to the physiological effort associated with *maintaining* a contraction.

With regard to (*a*), muscle is made up of a viscous material, not unlike egg-white or treacle, with a fine network of membranes, fibres, and tubes throughout it: the joints, the tendons, the connective tissue, the blood-vessels and the blood within them, are similarly of a viscous nature. Now, when a viscous fluid is forced to flow, mechanical energy is wasted and turned into heat: the faster it is made to flow, the more energy is degraded. But when a muscle changes its form, and produces a movement in a limb, the tissues have all to fall into a new form, viscous fluid has to flow into a new disposition, energy is degraded into heat: and in the more rapid movement we should expect more energy to be wasted. Experiment amply confirms this expectation: the frictional loss is greater, the greater be the speed of movement. This explains why it is so laborious to pedal a bicycle on too low a gear, and why very rapid running requires such an enormous amount of energy. In both cases the external resistance may be small or negligible. The internal resistance, however, is large, and increases directly as the speed of movement, until finally a limit is reached at which no further increase in speed is possible; every muscle fibre is then working to its physiological limit of speed and power, merely in overcoming its own internal resistance.

With regard to (*b*), just as it is inefficient and tiring to move our limbs too rapidly, or on too low a gear, so also it is inefficient and tiring to move them too slowly, or on too high a gear. This simple observation gives us the clue to the third and final reason why the efficiency of muscular contraction is relatively so low; a contraction which continues too long requires energy to maintain it, as well as energy to set it up, and from the point of view of doing external work the *maintenance* of contraction is ineffective. Experiments were made in which the heat produced by a muscle was determined as a function of the duration of the stimulus exciting its contraction. After an initial outburst of energy associated with setting up the contraction, the heat-production increases uniformly as the duration of the stimulus is increased. Hence we see why slow and prolonged movements are inefficient: a large and unnecessary part of the energy is used in maintaining the contraction. This is the phenomenon we all know in our own bodies: to attempt to lift a thing which is too heavy for us to move is more tiring than actually to lift a thing we can move, even though no work at all—in the mechanical sense—be done in the former case.

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Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

Labour and the Universities.

THE subject of "Labour and the Universities" was included in the agenda of the annual conference of the Universities of Great Britain and Ireland held in London on May 13. Mr. Arthur Greenwood, M.P., who opened the discussion, said that the Trade Union, Co-operative, and other working-class movements needed in an increasing measure trained men with the broad outlook and the other qualities which a university education could give; but he did not believe they were getting a fair share of the existing resources. This defines one part of the problem of Labour in relation to the universities in the simplest and clearest language. Admittedly the problem is not yet solved: but, as Prof. Elton of the University of Liverpool said, there is a disposition on the part of the universities to do all that can be done to find the solution. He invited Mr. Greenwood and his friends to tell the universities plainly what they wanted, coupling the invitation with a hint that the Labour Party must not expect the teaching of such subjects as economics and history to be adapted to the political tenets of their party. "Some sections of Labour," Prof. Elton said, "suspected that university economics might be capitalistic economics, and that history might be some form of Imperial history"—a suspicion which he believed to be unfounded.

One other warning might have been added. The educated man is not created *per saltum*: he is the product of years of toil, sacrifice, dedication. It may be true, as Mr. Greenwood said, that knowledge and an enthusiasm for knowledge would give the working classes something which no trade depression could take away. But how much study would this require? With the rapid advance of knowledge in all subjects, the problem of education becomes more and more complex for everybody, but especially for those who, under our present social system, are obliged to devote most of their time to forms of labour which are remunerative only in a physical sense. Prof. Burnet, in his recent Romanes lecture, warned us that specialism, pushed to its logical conclusion, would land us in a society where no one knew anything that any one else knew. There is real danger that working men may look with indifference on the Mount Everest of science. It is fair to say, however, that the higher education of the working classes, as directed and inspired by the Workers' Educational Association, has shown a disposition to encourage the thorough and humane study of a relatively small field in a spirit which gives to the student not only

knowledge of facts but wisdom to understand and interpret:

> "Knowledge is proud that he has learned so much;
> Wisdom is humble that he knows no more."

If, as we hope, there is no confusion of ideals in regard to the higher education of the working classes, questions of method and machinery should not present insuperable difficulties. The needs of the adolescent are, in many respects, distinct from those of the adult. Representatives of the Labour Party have often contended that there is at present in the youth of the working classes a great "stream of talent" which is allowed to run to waste. This contention has never been fully proved; but if it is true, the blame must rest with the Board of Education and the local education authorities for neglecting their statutory duties. As to the adult, the tutorial class and summer course are methods which have stood the test and yielded good results. The Master of Balliol, in a paper read at the conference, said that the summer school required to be better organised and more developed. Sixteen years' experience had shown what potentialities were in that direction. Another possibility was the organisation of one-year courses of intensive study in universities for selected extra-mural students so that adult education might breed its own teachers. Finally, he suggested, there was a need to develop the system of resident tutors in districts—"decentralised university work."

So much on the question of what the universities can do for Labour. There remains the converse question—what the Labour Party can do for the universities?—a question which has assumed greater importance since the Labour Party became His Majesty's Opposition. It is gratifying that the Labour Party, alone of the great political parties, has made the question of university education the subject of formal investigation and study. Their memorandum of evidence submitted to the Royal Commission on Oxford and Cambridge Universities, and recently published in the Appendices to the Report, gives proof of an earnest desire to make our ancient universities more efficient in a national sense. The memorandum is unsigned, and it is therefore difficult to determine its final authority. It speaks throughout, somewhat oracularly at times, in the name of the Party. Occasionally, however, the views expressed appear to have a personal character. For example, can it be supposed that the average member of the Labour Party, whether a horny-handed son of toil or one of the so-called "intellectuals," feels with any intensity of conviction that "the old Pass course both at Oxford and Cambridge should be abolished"?

There is much to be said for the view that specialisation has been carried too far in university education and that, for teachers particularly, a broader course of study than is at present offered by the Honours schools is to be preferred. In the United States, the first degree is granted on a general course of training, specialisation being postponed to a later age. Proposals to introduce "honours" degrees on the English pattern have been vigorously resisted in America on the ground that it is undemocratic to label some citizens as intellectually superior to others. Should not these questions of curricula be settled by educational experts rather than by work-a-day politicians?

The control of the universities which receive financial aid from the State is on a different footing. The memorandum states that "the Labour Party does not wish to deprive the universities of their independence; on the contrary, it would encourage their initiative within the national educational system"; but it goes on to assert that "something of the nature of continuous administrative control by the State must be undertaken." Thus are our universities to be placed on the slippery slope which leads to intellectual regimentation. Questions of new developments in literary and scientific research in universities will have to be submitted to Government officials as are, under present arrangements, questions of supplies for elementary schools.

No doubt co-operation and co-ordination could be carried further in university education, and the Government might stimulate the self-activity of the universities in these matters. But the doctrine of continuous administrative control is fraught with danger. Mr. Wood, the president of the Board of Education, speaking at the conference, admitted this. "In my judgment," he said, "if the universities are to fulfil their functions and duties, it is vital that they should retain the fullest measure of liberty possible. There is at present no disposition to challenge that principle. So long as the universities can justify the work that they are doing, so long, I think, Parliament will be prepared to trust the universities to do it."

Psycho-analysis.

(1) *Conditions of Nervous Anxiety and their Treatment.* By W. Stekel. Authorised translation by Rosalie Gabler. Pp. xii+435. (London: Kegan Paul and Co., Ltd.; New York: Dodd, Mead and Co., 1923.) 25*s*. net.

(2) *Some Applications of Psycho-Analysis.* By Dr. Oskar Pfister. Authorised English version. Pp. 352. (London: G. Allen and Unwin, Ltd., 1923.) 16*s*. net.

(3) *Psychological Types: or the Psychology of Individuation.* By Dr. C. G. Jung. Translated by H. Godwin Baynes. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. xxii+654. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co. Inc., 1923.) 25*s.* net.

(4) *Psychology and Politics, and other Essays.* By Dr. W. H. R. Rivers. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. vii+181. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co. Inc., 1923.) 12*s.* 6*d.* net.

(5) *Conflict and Dream.* By Dr. W. H. R. Rivers. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. xi+195. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co. Inc., 1923.) 12*s.* 6*d.* net.

(6) *Problems in Dynamic Psychology: a Critique of Psycho-analysis and Suggested Formulations.* By Dr. John T. MacCurdy. Pp. xv+383. (Cambridge: At the University Press; New York: The Macmillan Co., 1923.) 12*s.* 6*d.* net.

(1) THE physician who makes acquaintance with psycho-analysis in this, the first of Dr. Stekel's clinical works to be translated, will assuredly experience some kind of emotional reaction. The author takes for granted that therapeutic aims should not be hindered by reticence or taboo, but although medical men have accepted that principle in regard to the anatomy and physiology of sex, yet its application to the psychological factors is, in the form presented by Dr. Stekel, so thoroughgoing as to arouse certain opposition. The reader may capitulate in face of the mass of clinical evidence, or find in the frequent and facile dogmatism of the author a reason for rejecting whatever appears strange or new. The statement, for example, that "the sex impulse may be directly identified with the instinct of self-preservation" (page 3) is presented with no evidence or explanation, and we are left to guess whether it is a tenet of psycho-analytical orthodoxy or one of Dr. Stekel's own bright thoughts.

The many blemishes of this nature are unfortunate, for the book fills a gap in medical literature by its detailed accounts of the bodily symptoms of the anxiety states, symptoms which are commonly treated from the physical point of view with a total neglect of the underlying mental condition. Heart and stomach neuroses, asthmatic attacks, even the anxiety attack itself, rarely meet correct recognition, and Dr. Stekel gives clinical examples of all these with the mental factors fully analysed; a host of other disorders—phobias, professional neuroses, stammering, and the like—are adequately illustrated. The psychical treatment of epilepsy is approached with commendable caution, but the enthusiasm and confidence with which the author handles the therapeutics of melancholia are not shared by his analytical colleagues.

The book is a blend of useful information with rash dogma. The translation shows many literal errors and should have been revised by some one acquainted with medical terminology.

(2) Dr. Pfister combines the functions of pastor, pedagogue, and psycho-analyst, and his writings are regarded by psycho-analysts as serious contributions to their subject. In his opening essay he tilts at orthodox psychology, which certainly has failed to render to medicine or education the service that psycho-analysis offers, but in Great Britain at least the "psychology of the schools" no longer refuses to admit, however grudgingly, the importance of Freudian fundamentals. Pfister quotes from Stern the advice to differentiate between the actually perceived external fact and the interpretation attached to it. Psycho-analysts sometimes offend against this self-evident maxim in one direction, and their critics, on the other hand, often insist upon treating observations as if they were interpretative artefacts; it is notable that Pfister makes clear in his analyses what are the patient's associations—the perceived facts—and what are the interpretations.

Pfister's analysis of an artist and his art serves the double purpose of illustrating technique and studying the psychological processes of artistic inspiration, which is the manifestation of repressed desires and comes into line with neurotic symptoms and dreams, except that an ingenious whole is created. The latent significance of a picture is for the artist, the manifest is for others, but may not the success of an artistic production depend upon an unconscious appreciation, on the part of beholders, of the latent significance? In the chapter on "Psycho-analysis and Philosophy" Pfister acclaims Freud as the first great positivist among psychologists, but makes a plea for metaphysics as a stage towards the highest plane of knowledge. Of more immediate interest is the relation of analysis to ethics, for, as the author points out, the most powerful argument of Freud's opponents is that his procedure is immoral. Ethics, he says, is an empirical science standing in need of purely objective and sober criticism (p. 299), and "all ethics which ascribe to experience an influence upon its standards (and another kind of ethics is scarcely conceivable nowadays) may derive the most important doctrines from these discoveries" (p. 195).

Educationally, psycho-analysis aids more in the removal of inhibitions than in the prescription of methods, and the chapter on "Child Life" is the most

useful in the book; it gives accounts of actual cases which show that the analytic method of approach is the most hopeful one for the understanding and treatment of the "neurotic" child.

There is a want of correlation between the different essays, and it is doubtful whether a reader new to the subject would find it made sufficiently clear: yet the book is useful to place in the hands of people who see only evil in psycho-analysis.

(3) It is not realised that Freud and Jung, starting with a general agreement upon observed material, have so far diverged that Dr. MacCurdy expresses the usual Freudian view when he writes "No attempt has been made to consider the theories of Jung because, quite frankly, I cannot understand them" (p. xiii of "Problems in Dynamic Psychology"). Yet, although Jung admits that his earlier book ("Psychology of the Unconscious") so aggravated the difficulty that "many otherwise able minds became utterly confounded" (p. 626), this book concerns practical psychology in a sphere where Freud offers little help. Psychological types have always been recognised: William James defined the tough-minded and the tender-minded, or the rationalist and the empiricist, and found the history of philosophy to be mainly that of a clash of temperament. Furneaux Jordan (whose work with Herbert Page on "Railway Spine" is a neglected but important chapter in psychological medicine) is credited by Jung as being the first to give a relatively appropriate characterisation of emotional types. Jung himself has already developed the ideas of introversion and extraversion as character types, and in actual life the want of *rapport* between these types is a matter of daily observation. He notes "the normal bias of the extraverted attitude against the nature of the introvert" (p. 472). A recent novel attained success with its picture of the dis-harmony between the introverted Mark Sabre and his extraverted wife, and whoever ventured to criticise the hero inevitably revealed, by the nature of his criticism, the nature of his own type.

Jung now carries his analyses of types to a finer degree of differentiation, according as they are marked by excess of feeling, thinking, sensation, or intuition. His description is often practical and understandable; the extraverted intuitive type, for example, to which commonly belong merchants, contractors, speculators, agents, politicians, etc., is to be recognised in actual life, and, though he makes no mention of the application, a knowledge of the different types in children should be a useful part of the pedagogic art. But his discussion of the type problem contains a good deal of what will appear to many readers as mysticism. His conclusion is that each type views psychic processes in a manner peculiar to that type; that every theory of the psychic processes is in its turn a psychic process; hence every individual supposes that there is only one interpretation of the psychic process, namely that which agrees with his type. "The scientific theorist is confronted with the disagreeable dilemma of either allowing mutually contradictory theories of the same process to exist side by side, or of making an attempt that is doomed from the onset to found a sect which claims for itself the only correct method and the only true theory" (p. 627). Whether one rests content with this conclusion is a matter of one's own psychological type.

(4) Dr. Rivers's mode of thought was so remote from the rationalisations of politics that it was not easy to imagine him in the political world; his candidature was only possible in the comparative calm of a university constituency, and these essays, as Prof. Elliot Smith says in his prefatory note, were a most remarkable form of appeal to parliamentary electors. It seems likely that as electoral propaganda they would have met with only moderate success; a serious study of "red-tape" as "an attitude which must be understood if we are to correct the evils now associated with government control," for example, lacks the emotional appeal of vituperation, and even in an educated constituency the belief in the intellectual power of political ideas is so strong that few voters would be attracted by the view that "no great movement is likely to succeed except under the leadership of one who is able to inspire a degree of confidence comparable with that which actuates the instinctive attitude of the animal herd towards its leader." In fact, Dr. Rivers's demonstration of the strength of the instinctive and unwitting motives in political and social life indicates the tactical weakness of his own unemotional and logical presentations. Nevertheless, those who turn away from the catch-words and pseudo-intellectualism of politics will find pleasure in these essays while regretting that the voice was that of one crying in the wilderness. Dr. C. S. Myers writes an appreciation of the work of the late Dr. Rivers, which expresses the feelings of all who knew him.

(5) In the opening lines of his preface Prof. Elliot Smith tells us that "The aim of this book is to give a sane interpretation of the significance of dreams . . ." and the implied criticism of other interpretations does not prepare us for the absence of emotion or prejudice that marks this posthumous work of Dr. Rivers. Accepting the truth of the main lines of the Freudian position, Dr. Rivers examined his own dreams by encouraging a half-sleeping state in which the thoughts came which furnished the explanation of the dream. Working also with the dreams of patients, he tentatively propounded certain views as alternatives to

those of Freud. Instead of a wish-fulfilment he regarded the aim of the dream as an attempt at the solution of a problem, generally associated with a current difficulty, while he ascribes the form of the dream to a regression to modes of activity characteristic of early life instead of to the influence of early desires. These differences are not of vital import; in fact, on page 98 reference is made to dreams and their analyses recorded by Freud himself, in which Dr. Rivers found a striking similarity with respect to the recency of the conflicts they reveal, and he suggested that the dreams of a patient under analysis may be influenced by the attention of the dreamer being led back to the experience of early life.

Dr. Rivers doubted the scientific value of free association as a means of leading back to the source of the dream, though there may be clinical value in the material thus obtained. Pfister, in the book reviewed above, admits this doubt when he writes (p. 38): "We do not by any means believe that *every* association . . . shows the paths by which the image under investigation was produced." Freud's conception of the "censor" is rejected in favour of the supposition that as sleep becomes deeper the dream takes on a more infantile mode of mental activity and hence is more disguised and more readily forgotten. In regard to the universality of symbolism Dr. Rivers was in more serious discord with psycho-analysts. By "universality" he did not mean the invariability of the symbolic meanings, for the existence of such invariability is not claimed; it *is* claimed, however, that certain symbolisms are innate and universal to all mankind, and this claim Dr. Rivers denied on ethnological grounds.

This book, with that of Dr. MacCurdy, should be welcomed by psycho-analysts. The vigour of the heresy hunt is now abating, but, more than from the intimidatory effect of the hunt, psycho-analysis has suffered from the absence of scientific criticism. The death of Dr. Rivers has meant the loss of one of its few understanding critics.

(6) Dr. MacCurdy assumes that his readers know and accept the observations of psycho-analysts, which he confirms from his studies of the psychoses, but when he examines Freud's theoretical principles he finds them, to his surprise, not internally consistent. He meets difficulty in Freud's conception of the ego and its relation to the libido and finds untenable the idea of the object libido being transformed into ego libido, while he rejects as arbitrary and unconfirmed Freud's pathology of dementia precox as a withdrawal of the libido from the outer world with a transformation into ego libido. He is content to regard the disease as marked by a central theme, often of a crude Œdipus order, and the problem is how such a theme can gain this ascendancy. English psychiatrists will perhaps be surprised at the entire neglect of the pathological findings in this disorder, but the physiological and psychological points of view seem to be mutually exclusive.

It is characteristic of Dr. MacCurdy's position that he criticises Freud's theories from a point of view that demands attention from Freudian orthodoxy, which has been compelled to ignore the criticism of those who without investigation dismiss the findings of analysis as absurd and void of psychic reality. In the case of the war neuroses, to quote a simple example, the use of an easy technique demonstrated the existence of buried memories that expressed themselves in the bizarre symptoms of shell-shock, but discussion was impossible with objectors who refused to acquire the technique necessary to confirm or confute the observations. Similarly the significance of the birth-phantasy—a common-place finding of analysis—has not hitherto been subjected to useful criticism. But Dr. MacCurdy rejects as a wild speculation the idea that unpleasant feelings at birth have become the prototype of anxiety and are repeated in states of anxiety (it is curious that the same hypothesis was propounded by Erasmus Darwin in "Zoonomia"); he agrees that mythology, delusions, and dreams are replete with examples of birth experience, but points out that the unconscious ideas of painful birth may originate in later life and have psychic reality without being memories at all. He agrees, too, that each analyst finds what he is looking for, but declares this a matter not of suggestion but of selection, and believes that even with this partial selection cure results as soon as sufficient unconscious energy is deflected from symptoms to constructive activities. A chapter is given to an appreciative but critical examination of the theories of Dr. Rivers.

This important book is constructive as well as critical, and ends with a consideration of the co-operation and conflict of instincts and the statements—in which psycho-analysis takes the offensive—that "Ego and sex instincts, when in the ascendant, lead to the destruction or ineffectiveness of the individual," but "The world of men suffers and has suffered more from . . . insensate devotion to the herd than from all crime, insanity, or nervousness."

Millais Culpin.

Chinese Potters and Porcelain.

The Wares of the Ming Dynasty. By R. L. Hobson. Pp. xvi+240+59 plates. (London: Benn Bros., Ltd., 1923.) 84*s*. net.

This admirable account of the arts and crafts of the Chinese potters and porcelain-makers during those spacious days of its history when the Celestial

Emperors held sway over the larger part of eastern and central Asia is worthy of its great subject; and one could not award it higher praise. The position of Chinese porcelain is so commanding in the history of man's art and craftsmanship, and its example and influence have proved so dominant in Europe, as well as in the Far East, that so comprehensive and reasoned a survey of its development will prove of signal interest to all lovers of fine and noble porcelains; whether their predominant interest is centred in the wares of Asia or in those, of later date, that have been made in Europe. Only an untiring student and scholar, who has charge of a famous collection such as that in the British Museum, and who has worked, there and elsewhere, at the subject in all its aspects, could have produced a volume of such sterling worth. All available sources of information have been utilised—the accounts of early European travellers are drawn upon equally with the latest records of exploration and research—so that we are here presented with as trustworthy an exposition of the subject as we are likely to obtain, and one which might well serve as a model for later workers in similar fields.

It is refreshing and gratifying to find such an authority as Mr. Hobson dealing so outspokenly with some of the common misconceptions cherished by many dealers and collectors. "Misconceptions about Ming are so many, and the word has been so frequently abused, that it will be well to devote a little destructive criticism to the things which are not Ming, but too often masquerade as such. . . . Ming is not a home for stray pots, in which every mongrel piece, which has no fixed attribution, can find a refuge. . . . Not long ago all glazed pottery figures were called Ming as a matter of course. No self-respecting merchant would have thought of stocking anything later in that line of goods, . . . etc." These are but two examples of many that might be cited where Mr. Hobson, as befits his position, has performed a real service to students and collectors alike; but many such illuminating *dicta* occur throughout the work, and it is encouraging to find valuable advice and information conveyed in such an authoritative and unhesitating a fashion.

Two special chapters are devoted to a consideration of Ming technical methods, and they have been compiled in such a way as to provide a sound and trustworthy foundation on which the collector may base his own knowledge. In addition to a clear and succinct account of the raw materials used in the body and glazes and the regions whence they were obtained, there is a description of how the more important varieties of porcelain were fashioned, finished, painted, and fired. The subdivision of labour "which effectually obliterated the individuality of the decorators" is explained, as well as the fact that the painted designs were mostly based on well-known paintings and on such standard patterns as those used in silk-brocades. These had been filtered through the hands of the Palace artists, whose designs were sent to Ching-tê Chên to be copied on the ware by the porcelain decorators.

As an example of concise statement it would be difficult to surpass Mr. Hobson's account of the method by which gold was applied to the Ming porcelains. "Gilding was used from the earliest reigns of the Ming. It was the last operation in the manufacture and always required a separate firing at a low temperature. Thus one of the red bowls described will be fired first in the full heat to take the body and glaze and develop the underglaze blue inside the bowl, then it would have the outside covered with red enamel which had to be fixed in the muffle stove; and finally the gilt floral pattern would be painted over this red and fixed by another visit to the muffle. In several cases the gilding on these red bowls is applied in the form of gold leaf, while in others it was evidently painted on with a brush."

Space will not permit me to dwell further on the merits of the work, but attention must be directed to the excellence of the numerous illustrations and the selective skill with which objects have been chosen to cover, adequately, such an extensive field. The coloured plates are of remarkable excellence; the subtlety of the Chia Ching bowl decorated with enamel colours (plate 7) being as perfectly suggested as is the precision of the design of an earlier type, in a more conventional style, which appears as the frontispiece. The half-tone plates are equally successful, and as the objects chosen are often of extreme beauty, they undoubtedly add to the value and distinction of the book.

WILLIAM BURTON.

Maps and Survey.

Maps and Survey. By Arthur R. Hinks. Second edition. Pp. xvi+258+26 plates. (Cambridge: At the University Press, 1923.) 12s. 6d. net.

THIS new and enlarged edition of Mr. Hinks's book is heartily to be welcomed, for it forms an admirable introduction to the whole subject of map-making, both in the field and in the office. Indeed, in some respects, it is more than an introduction, for such chapters as "Maps and Survey in War" and "New Methods of Survey" can be read with advantage even by those experienced in the construction of maps. An excellent feature of the book is its wide outlook; thus examples are given of methods of work and of instruments used, in the United States, in France, in India, and in the British Protectorates and Colonies,

as well as those employed by the Ordnance Survey and in British military practice at home.

In his preface to the second edition the author states that it should be considered as transitional from the pre-War subject which he taught in the geography school at Cambridge "to the considerably developed and altered maps and survey" which have come within his experience at the Royal Geographical Society. It is a fact that not only has the subject altered considerably in recent years under normal conditions, but also the War has brought forcibly to the attention of surveyors the great value, in suitable circumstances, of air-photo-surveying and of photographic methods generally; while in peace-time exploration the use of wireless time signals for the determination of longitude has removed the traveller's greatest technical difficulty.

An interesting addition is entitled "A further Chapter on Maps"; it deals with some of the many problems which are now before the cartographer, such as flying maps, the international air map, the spelling of place names, and styles of lettering. As an example of the difficulty of meeting the airman's requirements it is pointed out that, on the international air map, the sign for Brest must indicate aerodrome, sea-plane station, wireless, radio-goniometer, wireless telephone, meteorological station, aerial light and aerial ground-sign: a striking example of the difficulty of selecting conventional signs. While dealing with the subject of conventional signs it may be mentioned that the Ministry of Transport and the Ordnance Survey are now publishing a new set of half-inch maps of Great Britain, giving the new road classification and the road numbers approved by that Ministry. The issue of this series of maps has taken place since the book under review was published. The chapter ends with an analysis of more than thirty new types of maps, mostly published since the first edition of this book was printed.

The account of maps and survey in war is excellent, and is chiefly based on the experience of the British Army on the Western Front. Some of our cartographic difficulties were caused by using a grid marked in squares of a thousand yards' side printed over maps, with dimensions derived from the Belgian Survey, which were a definite number of kilometres in length and depth. Then as regards the projection, both French and Belgian peace-time maps were plotted on Bonne's projection, which gives equivalence of areas but is not well suited for military use. Both English and French survey staffs came to the conclusion that it was desirable to adopt a form of orthomorphic projection, and the French in 1917 introduced a close approximation to Lambert's conical orthomorphic projection. Arrangements had been made for the British to follow suit, when the War came to an end. Of course the quality of orthomorphism only strictly holds locally, but for some miles it is sensibly exact. These questions of the grid and projection have their importance, but it would be wrong to overestimate it. Generally speaking, the British maps on the Western Front were excellent, and compared most favourably with those of the enemy; and it was undoubtedly right to start with the Belgian projection and size of sheet—in no other way could the maps have been produced in time to be of use in the early days of trench warfare.

The book ends with an account of photo-stereoscopic survey, including a description of the stereo-autograph of von Orel—of the Military Geographical Institute of Vienna—another instance of the debt which the arts of surveying and cartography owe to the armies. This stereoscopic method has a future before it, but at present the price of a von Orel machine is high, and it is to be hoped that some less costly and less elaborate piece of apparatus may be devised which will be equally efficient. As the author remarks, however, the method is not easily applied to flat country without commanding points of view, and is not suitable for very small scales.

It will be seen that Mr. Hinks's book is in effect an excellent account of the present state of surveying and cartography, and all interested in these subjects will find the book well worth perusal and study.

C. F. C.

The Drapers' Company and Statistical Research.

Department of Applied Statistics, University of London, University College. Drapers' Company Research Memoirs. Studies in National Deterioration. IV.: On the Relationship of Health to the Psychical and Physical Characters in School Children. By Prof. Karl Pearson. Pp. 77. (London: Cambridge University Press, 1923.) 15*s*.

IN this most recent of the Drapers' Company Research Memoirs Prof. Karl Pearson discusses the relationship of health to the psychical and physical characters of school children, on the basis of information supplied by selected schoolmasters and schoolmistresses, some years ago, in respect of more than 2000 boys and 2000 girls in schools for the professional classes. The information represents, as it were, the collective considered and recorded judgment of the masters and mistresses who contributed, and previous examinations of the data have afforded evidence of trustworthiness. Prof. Pearson finds that the statistics show little relationship between health and the characters considered: the healthy

child is rather more intelligent, vivacious, and self-assertive and considerably more athletic than the less healthy, but the physical characters (head measurements, hair, eye colour, etc.) show no relation on which stress could be laid. In the course of the work the author sums up in general terms what the statistics show to be the athletic and the popular child. The latter is intelligent, conscientious, athletic, healthy and good-natured or quick-tempered rather than sullen: self-assertive children are a little less popular than the shy. Red-haired boys and wavy-haired girls enjoy a large share of popularity but in other respects appearance seems unimportant. The athletic child may be summed up as a "healthy, reasonably intelligent, and fairly conscientious, if somewhat self-assertive and undoubtedly noisy child who is quick-tempered, but not sullen . . . in several respects better, in none worse, than the average child."

No one will, in all probability, cavil at these results, but Prof. Pearson before reaching them had to examine the effect of age on the various characters, and in this part of his work he comes to conclusions which, he seems to think, will find less ready acceptance. These conclusions are that general intelligence and a variety of psychical characters seem to be unchanged throughout school life, that general health changes exceedingly little during the same period and the statistics do not support the "widely-spread opinion that Health is a governing factor of temperament." Our surprise is not so much at the results as at the expectation of disagreement. As general intelligence is described as a measure of capacity and not of acquired knowledge, the teacher's work is, in a sense, eliminated from the calculation, and surely any masters or mistresses may feel satisfied if school influence teaches control of temper although it cannot make the quick-tempered child into an even-tempered one. The author's analogy is to the point: you will need to harden, temper, and grind your chisel if it is to become efficient for its task, but no amount of treatment will permanently convert bad steel into good steel. With regard to the conclusion that general health changes little with age, this might have been anticipated, because rates of mortality and sickness increase but little with the age during the years of school life, and the "widely-spread opinion" to which reference is made by Prof. Pearson is perhaps the outcome of a kindly wish to make excuses for the temperamental shortcomings of an unhealthy person. But, after all, the only practical way of reaching conclusions on such matters is by collecting evidence from samples of the population as Prof. Pearson has done, and the conclusions so reached are preferable to those general impressions on which people form their opinions regardless of the fact that few of us take account of all the cases that pass before us, but are tempted to rely on the relatively small part of the experience, which by its rarity rather than its frequency creates an impression.

The Memoir was prepared as a lecture, and while giving a careful discussion of the statistical problems, etc., it contains remarks intended to make it attractive to a listener: these lighter touches make it easier, but no less pleasant reading than some of the more severely mathematical work that has been published in the same series.

This brings us to another aspect of the Memoir to which we may direct attention. It is the latest of a very large number of productions that bear the name of the Drapers' Company. For twenty years or so, papers have been written and issued from University College with the help of this Company. The Memoirs include much original work on the theory of statistics; the three volumes on albinism with which Nettleship and Usher were largely concerned—a storehouse of information—monographs on anthropometric subjects, many technical papers, studies in fertility and disease, and, in some respects as important as any of these, the tracts for computers and the volume of tables for statisticians. It would have been a great output for the period for any department—even if its other activities were ignored—but it would have been an impossibility if there had been no financial help available. The Drapers' Company has helped science in other ways, and it must be gratifying to such generous givers to see the help used to so good a purpose, and to know, as surely the Company must, that its gift is appreciated, for the help it affords to scientific research, by many people besides those connected with the Department or the College to which the grant is actually made.

Our Bookshelf.

Hutchinson's Splendour of the Heavens: a Popular Authoritative Astronomy. Edited by T. E. R. Phillips. (In about 24 Fortnightly Parts.) Part 1. Pp. 48. Part 2. Pp. 49-88. Part 3. Pp. 89-128. (London: Hutchinson and Co., 1923.) 1*s.* 3*d.* net each part.

THE name of the editor of this serial, the secretary of the Royal Astronomical Society, is a sufficient guarantee of the excellence of the work. As collaborators he has gathered together a band of observing members of the Society, each an expert in one or other of the subjects which will constitute the work. The salient feature of the parts which have appeared is the beauty of the plates and of the illustrations which are scattered so lavishly over their pages. Sources both ancient and modern have contributed a veritable picture gallery of the science. This will appeal to both young and old, to the student, and not less to the adept.

The descriptive matter too is not unworthy of the pictures. The writing is popular in the best sense of the term, simple, but yet exact in the exposition of the fundamental laws and the progress of observation of the physical facts of the science. The explanations are rendered more intelligible by apposite and original diagrams. After a general and historical introduction by the editor, Dr. Steavenson treats of the "Story of Light and Man's Control of It," with illustrations of telescopes from that of Galileo to the giant 100-inch reflector at Mount Wilson. Spectroscopy is adequately explained, and the chapter concludes with an account of the astronomical applications of the interferometer. Of Chapter II. "The Solar System," it is enough to say that it is in the very capable hands of Dr. Crommelin. It is a model of popular scientific style. "The Sun and Sun-spots" constitute Chapter III., written too in a fascinating manner by Mrs. Maunder, and copiously illustrated by very fine photographs, mainly from Greenwich Observatory. Mr. C. P. Butler writes on the "Prominences," and the stars and nebulæ, meteors and comets, gravitation and tides are among the subjects yet to be discussed.

The title "The Splendour of the Heavens" is well chosen, for it is this aspect of the firmament which excites wonder and appeals most directly to the mind of man. It inevitably leads to the recognition of the Majesty, the Wisdom, the Beauty of the Creator, and is thus an antidote to the naturalism, and to the stark materialism which is the bane of much of modern science. With unstinted praise we can recommend this excellent serial, which promises to be a standard work of popular astronomy. A. L. C.

Guide to the Mollusca exhibited in the Zoological Department, British Museum (Natural History). Pp. 55. (London: British Museum (Natural History), 1923.) 1*s.*

A NEW edition of the Guide to the Mollusca in the British Museum (Natural History) has been certainly long overdue, none having been issued since 1908, when other Invertebrata were associated with the Mollusca in the descriptive account of the "Shell and Starfish Galleries."

This new Guide occupies practically the same number of pages as did the section of 1908, although much of it has been rewritten, and in its "get up" is fully equal to others of its kind for which the Natural History Museum is famous. It cannot be exactly described as a "popular guide"; the subject does not lend itself to that, as the mammals and birds do, but it appeals rather to more advanced students of the particular subject. The casual visitor desirous of more simple explanation can fortunately rely on obtaining the information he may require from the demonstrations of the Official Guide, who alone probably can satisfactorily deal with such. No one who has not attempted a similar production knows how difficult it is to produce a really satisfactory work of the kind, or of the pitfalls that beset the compiler, to whose own lapses may be added those introduced by the "familiar" of the printing press.

Beyond pointing out that the scientific name of the British freshwater pearl mussel has somehow been applied to the marine pearl oyster of commerce (Pinctada), we do not propose to dwell on those errors we have observed, preferring to leave that task to "kind friends." It is a pity, however, that further currency has been given to a text-book statement that a "*Helix* has been known to survive a temperature of $-120°$ C." and even to have strengthened the startling statement by substituting "tolerate" for "survive." We suggest a lost decimal point as explanation.

Physikalische Chemie der Zelle und der Gewebe. Von Prof. Dr. Höber. Fünfte, neubearbeitete Auflage. 1 Hälfte. Pp. xv + 544. (Leipzig: W. Engelmann, 1922.) 575 marks.

THE late Prof. Benjamin Moore reviewed this important book at length in NATURE (November 30, 1911, vol. 88, p. 140) upon the appearance of the third edition. The general character of the book is unaltered in this the fifth edition, and it still remains one of the outstanding texts for the use of students of physiology.

The present edition has evidently been completely revised, the most striking modification being the division of the book into two main sections; the first dealing with the underlying physico-chemical phenomena apart from their manifestation in the living organism, the second part considering the operation of these phenomena in living cells and tissues. The book also now appears in two volumes; this first volume includes the six chapters comprising the first section of the book, while Chapter VII., the first chapter of the second section, discusses the osmotic properties of cells and tissues. The material of this seventh chapter in the third edition appeared scattered throughout three chapters dealing respectively with osmotic pressure, osmotic properties of cells and tissues, and a criticism of the lipoid theory. Judging by the present volume, the rearrangement of the subject-matter has provided a more natural and logical presentation of the subject. It is also certainly natural to find that a discussion of permeability no longer centres around the lipoid theory of the plasma membrane. Throughout the book modifications have been made in accordance with the trend of modern physiological investigation; to cite one example, Chapter III., upon the quantitative estimation of hydrogen ions, has been altered to cover the modern use of a wide series of indicators in conjunction with standard buffer solutions; it also includes a fuller discussion of the regulatory mechanism controlling the reaction of the blood.

English Coastal Evolution. By E. M. Ward. Pp. xii + 262 + 14 plates. (London: Methuen and Co., Ltd., 1922.) 8*s.* 6*d.* net.

MR. WARD has chosen a very interesting subject, and has treated it systematically and well. In his general introduction, he points out that the present features of our coasts are built up or carved out on a land that has been recently submerged. The features of this land are largely due to subaerial erosion, but in places they are becoming modified by the deposits caught on sea-worn flats. In other places features are becoming again revealed by the removal of beach-detritus belonging to an earlier epoch. The glacial deposits that extended the land-area as the ice melted away form here and there protective

barriers, but have little stability against the battery of the waves. The pictures of coastal "planes of marine denudation" (Ramsay wrote "plains" for his larger features) are pleasing examples of the many excellent photographic illustrations.

The English and Welsh coasts are dealt with by districts, which is a far better method than any attempt to distinguish coasts of accumulation from those where erosion is now active. The descriptions thus appeal to readers who know the landscapes, and they add much in the way of local geography for dwellers near our shores. The descriptions of the Chesil Beach and the coves of the Dorset coast may be cited as examples of this treatment. Note has been taken of the probable derivation of the big stones of the Chesil Beach from flint-gravels formed on lost but adjacent land. The re-opening of Pagham Harbour in the Selsea area by a heavy gale in 1910 provides a parallel on a small scale with the flooding of the lands west of Dordrecht in 1421. The loss and gain of land in East Anglia is illustrated by many details and references that show the wide reading of the author.

This readable book forms a sound basis from which a historian might proceed to a study of our maritime industries, our relations with the continent, and our great adventures overseas. G. A. J. C.

The Statesman's Year Book: Statistical and Historical Annual of the States of the World for the Year 1923. Edited by Sir John Scott Keltie and Dr. M. Epstein. Sixtieth Annual Publication: Revised after Official Returns. Pp. xxxii + 1583. (London: Macmillan and Co., Ltd., 1923.) 20*s.* net.

THE sixtieth issue of this well-known work of reference shows the same high degree of accuracy for which previous issues have been distinguished. The information for every country for which statistics are available has been carefully revised, and the same applies to the full lists of works of reference dealing with every part of the world. For the first time Turkey appears shorn of its old-time possessions, which now figure either as independent states or as mandated territories of other states. The new conditions in Ireland have resulted in two new sections devoted respectively to Northern Ireland and the Irish Free State. In default of separate figures, certain statistical information for Ireland has still to be included under Great Britain and Northern Ireland. The term United Kingdom would seem to have disappeared. The two coloured maps in this issue show respectively Ireland, and Palestine with Trans-Jordan. There are the usual statistical tables and a section on the League of Nations. A voluminous index enhances the value of this well-arranged volume.

Lands of the Thunderbolt: Sikhim, Chumbi, and Bhutan. By the Earl of Ronaldshay. Pp. xvii + 267 + 32 plates. (London, Bombay and Sydney: Constable and Co., Ltd., 1923.) 16*s.* net.

THE barest record of the journeys made by Lord Ronaldshay from Darjeeling into Sikhim, Chumbi, and Bhutan, could scarcely fail to be of interest. Sikhim is probably the most mountainous country in the world, while both Chumbi and Bhutan are little known to Europeans. Lord Ronaldshay's record, however, has the added attraction that he is intensely interested in the curious lines of thought of the peoples he met. These are the result of that combination of Buddhism and the animistic beliefs of primitive Tibet which we know as Lamaism. In Lamaism, the rationalistic philosophy of Buddhism, of which the author gives a succinct account, coexists side by side with a belief in "devils," and the efficacy of the praying wheel, a reverence for repetition and an unquestioning faith in number, most strikingly manifested in the endless reiteration of religious formulæ as an effective exercise of piety. The result of the incongruous combination is strikingly manifested in a weird ceremonial in which such observances as the devil dances of the Black Hat and the bizarre pantomimic dances of Bhutan play a prominent part. Lord Ronaldshay's record of his observations is illustrated by a large collection of photographs, many of great beauty, taken by himself.

Food, Health, and Growth: a Discussion of the Nutrition of Children. By Dr. L. Emmett Holt. Pp. xi + 273. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1922.) 7*s.* 6*d.* net.

THIS book embodies a series of five lectures on certain important and interesting topics relating to child nutrition. The objects are to demonstrate the relation of nutrition to health and growth, to state the requirements of children during the period of growth, and to discuss how these requirements may best be met. Considerable attention is paid to the accessory food factors.

The most important chapter is the last, which deals with practical measures. Dr. Holt believes that the only way of dealing with health problems, including that of errors of nutrition, is by education of children in matters of personal hygiene, and he suggests that much can be done in schools to make the teaching of health interesting and its practice attractive.

The book contains much that is useful and interesting to the general reader, and its understanding requires no previous scientific knowledge of nutritional principles.

The Chemists' Year Book, 1923. Edited by Dr. F. W. Atack, assisted by L. Whinyates. Vol. I. Pp. iv + 422. Vol. 2. Pp. vii + 423-1107 + xv. (Manchester: Sherratt and Hughes, 1923.) 2 vols., 21*s.* net.

"THE Chemists' Year Book," which is the English equivalent of the "Chemiker Kalender," is now approaching the latter in completeness. In the present issue there has been some revision, and a new section, on "Leather Analysis," has been added. It is worth considering whether the space taken up by such descriptions of analytical methods, which would usually be sought in special manuals, could not be better used in giving further numerical data. Thus, the section on thermochemical data, or sections rather, since the material is dispersed, cannot compare with the information in the "Chemiker Kalender." The price is also very high for a book which is to be replaced every year.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Effect of Infinitesimal Traces of Chemical Substances on Photosynthesis.

THE possibility of ultra-measurable traces of certain chemical substances affecting assimilation is a matter of much importance in physiology. The carbon-assimilation of water-plants affords an extremely sensitive process for the investigation of the subject. The usual method of counting the number of bubbles of oxygen given out by the plant under light is, however, most untrustworthy for quantitative determinations, since the size and frequency of the bubbles undergo spontaneous variation. This difficulty has been completely removed by a new device which I have been able to perfect, by which the evolution of *equal volumes* of oxygen is automatically recorded on a revolving drum by an electromagnetic writer; records thus obtained enable us to determine the normal rate of photosynthesis and its induced variations. I have also found that there is a definite relation between the evolution of oxygen and the formation of carbohydrate in the leaf. The automatic apparatus referred to can be so adjusted that the successive dots in the record represent the photosynthetic production of amounts of carbohydrate as small as a millionth of a gram. It is impossible in this short communication to give a detailed account of the apparatus, which will be found fully described in my forthcoming work, "The Physiology of Photosynthesis," to be published by Messrs. Longmans.

My attention was directed to the possible effect of traces of chemical substances on carbon-assimilation by the extraordinary increase in the photosynthetic activity after the thunderstorm and rain which lasted from February 10 to February 13 of this year. The coefficient of photosynthetic activity of the aquatic plant, *Hydrilla verticillata*, growing in the pond of the Institute, had been carefully determined for January and for the first week of February, and found to be practically the same in different specimens. The coefficient for light, *i.e.* the ratio of increment of activity to the increment of light, was found to be 13·2 per 100 lux immediately before the thunderstorm (February 9); whereas after the thunderstorm it was found to be 26·9, the activity having been thus increased 100 per cent; later the value decreased by stages to 22·9, as if the beneficial effect of the thunderstorm were subsiding to a certain extent. There was no variation of temperature, which remained constant at 22° C.

The rain could not have produced any variation of turgor in the plant, which was submerged in water. A plausible explanation of the enhanced activity is that the electrical discharges during the thunderstorm produced oxides of nitrogen which, washed down by the rain, added traces of nitric acid to the water of the pond in which the plants were growing. The quantity thus added would, however, be inconceivably minute. The correctness of the above hypothesis may for the present be left an open question. There can, however, be no doubt that minute traces of nitric acid exert a potent influence on photosynthetic activity, as is shown by the results of the following experiments carried out under constant light and temperature. At first I applied a dilution of one part in ten thousand which caused a depression of activity. I therefore went to the other extreme and prepared different dilutions of 1, 10, and 100 parts in 100,000,000,000. It is difficult to form any clear conception of ultra-measurable quantities from a row of zeros, and I will therefore, following the French system of measurement, designate a thousand millions as a billion. Application of a solution of one part of nitric acid in 100 billions induced no change in photosynthesis, but one part in 10 billions produced a marked increase in activity of about 100 per cent; 1 part in 2 billions caused a further increase of nearly 200 per cent. This was the climax. The enhanced activity underwent a slight decline at dilutions of one to ten parts in a billion, the activity being still greater than the normal by 100 per cent. There was an abrupt depression of activity at lower dilutions than 1000 parts in a billion (Fig. 1). The above figures may be taken to be typical of the effect of traces of nitric acid; for a dozen different specimens taken at random gave very similar results. In subtonic specimens, with

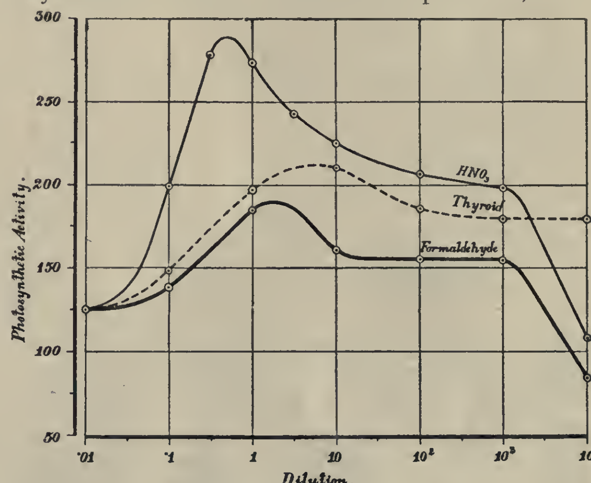

FIG. 1.—Curves showing effects of traces of nitric acid, of extracts of thyroid gland, and of formaldehyde, on the activity of carbon assimilation by the aquatic plant *Hydrilla verticillata*. The ordinals represent induced change in photosynthetic activity, the normal being taken as 100; the abscissæ represent dilution from 0·01 to 10^4 parts in a billion.

photosynthetic activity at standstill, an addition of two parts nitric acid in ten billions caused vigorous photosynthetic evolution of oxygen, the renewed activity persisting for a very considerable length of time.

I obtained similar increase in carbon-assimilation with traces of certain other substances of which I will give only two examples. The dotted curve in the middle of the figure exhibits the effect of extract of thyroid gland. Here the maximum activity was produced at a dilution of ten parts in a billion. The noticeable fact is that there was no reversal for a considerable range: the increased activity of about 80 per cent persisted up to the lower dilution of one part in a million.

The effect of traces of formaldehyde, which is a highly poisonous agent, is of much theoretical interest. A dilution of one part in a billion caused an increase of photosynthetic activity by 85 per cent. At higher concentrations, formaldehyde produced its normal poisonous effect. The action of traces of formaldehyde has special significance in regard to the "first product" of assimilation. According to Baeyer's theory, formaldehyde is one of the first products from which carbohydrates are formed by polymerisation. This theory labours under the difficulty that formaldehyde is extremely poisonous to plants.

The experiments just described, however, show that minute traces of formaldehyde are by no means poisonous, but actually enhance photosynthetic activity in a remarkable degree. The intermediate stages of transformation from formaldehyde to carbohydrate are likely to be rapid; there would therefore be no accumulation of formaldehyde to a poisonous degree.

At first sight it is inconceivable that infinitesimal traces of certain chemical substances could have such a potent influence on life-activity. There is, however, no doubt of the reality of the phenomenon.

J. C. BOSE.

Bose Institute, Calcutta.

Molecular and Crystal Symmetry.

I GATHER from Messrs. Shearer and Astbury's reply (NATURE, June 2, p. 740) to my former letter to NATURE (May 12, p. 632) that my mention of a paper by Fedorov has unhappily diverted their attention from the main issue. As any attempt to disentangle numerous side issues would only take up valuable space, I propose to confine my remarks to the few points connected with recent X-ray developments.

In attempting to show that I was in error in supposing that nothing can be said about the symmetry of the molecule until the position of every atom in it is determined, Shearer and Astbury invoke the X-ray evidence of benzoic acid; but it will be found on examination that their proof rests on an assumption that if two crystal molecules are symmetrically disposed with regard to a structural plane the molecular symmetry is thereby limited. My own view is that the molecular symmetry remains untouched, and that the actual X-ray results can be equally harmonised with any type of molecular symmetry, provided the molecules be orientated in a general way, *i.e.* so that no molecular plane or axis of symmetry be parallel to any structural plane or axis. What is, indeed, wanted is an experimental proof that a structural plane beset with molecules, individually symmetrical but facing the plane asymmetrically, is distinguishable from a plane studded with asymmetric molecules; but as such an experiment is unrealisable, I do not see how the symmetry of an individual molecule can be deduced without first determining the positions of every atom in the structure. Further, I fail to see how Messrs. Shearer and Astbury can take a different view, for if the molecular symmetry of a complex organic compound can be deduced from X-ray measurements, what object was there in advancing Shearer's rule? If it were really feasible, it would surely be better to solve the intimate structural details of benzoic acid by the method of experiment than by a process of speculation.

The only other subject I need refer to is that of tartaric acid. It now appears that my previous conjecture, that Astbury's crystal molecule is axially symmetrical, was erroneous, and that this substance is really in formal agreement with Shearer's rule. I may, however, point out that I was formerly particularly adverse to drawing any definite conclusion from such a complicated structure, a position which I see no reason to modify. In this connexion it is pertinent to add that evidence from simple compounds is already coming in. Dickinson's recent investigation of tin tetraiodide reveals 8 chemical molecules, each of a symmetry number 6, to the unit of structure; and as the symmetry number is generally held to be 24 (and not 48) the rule is correspondingly infringed.

In conclusion, it may be useful to add a word of explanation on the part played by Shearer's rule in X-ray investigations of organic compounds. In the typical case of benzoic acid classical methods of crystallography allow of the determination of the symmetry and also of the relative edge-lengths of the unit of structure. Building on this foundation the X-ray method goes further by determining the mass associated with this unit, its absolute dimensions and therefore volume, and, somewhat approximately, the relative positions of the centres of gravity of its constituent molecules. This represents a great advance to the crystallographer, but scarcely so to the chemist unless such molecular centres can be expanded into bodies of definite shape and atomic configuration. Now as volume determines neither external shape nor internal structure the problem is obviously one of great complexity, and X-ray results cannot usefully be applied to its solution on account of the enormous number of variables concerned in crystals of low symmetry and complex chemical composition; consequently, more general but less direct aids have to be relied on.

One method of bridging the gap is to adopt the hypothesis that atomic radii are approximately constant in crystals, whereby a radius determined from an element or simple inorganic compound can be carried over to a complicated organic compound. By such means spheres of appropriate sizes can be packed together in a tentative way so as to fill variously shaped cells of the correct volume, but there is obviously still much scope for varieties of arrangement and some further limiting principle is needed. That actually favoured at the present moment is Shearer's rule that a crystal makes the utmost use of the symmetry of its component molecules, or, alternatively stated, that the molecular symmetry is deducible as being the crystal symmetry divided by the number of molecules involved in the unit of structure. Since such a rule generally leads to low molecular symmetries (*i.e.* those which are practically consistent with any given arrangement), it is somewhat difficult to see how it can serve to limit the number of structural solutions. It can, however, be employed in a more superficial way, since the creation of an upper limit to molecular symmetry serves to rule out any stereochemical formulæ of still higher symmetry. Thus, it has been suggested that the Kekulé and Claus formulæ for benzene must be abandoned in favour of the Dewar formula, at any rate in the crystal.

Such results are obviously worthy of attention in so far as Shearer's rule is true. The present position is that the rule is a postulate and so also are the results that flow from it, ranging from the disposition of electrons in a crystal molecule of alumina to that of the atoms in any complex organic compound.

T. V. BARKER.

University Museum, Oxford,
June 16.

Stirling's Theorem.

MR. H. E. SOPER, in NATURE of May 5, p. 601, gives Stirling's Theorem in the form

$$n! = \sqrt{2\pi}\left(\frac{n+\frac{1}{2}}{e}\right)^{n+\frac{1}{2}} \times \exp.\left\{-\frac{1}{24(n+\frac{1}{2})}+\frac{7}{2880(n+\frac{1}{2})^3}+\ \cdot\ \cdot\ \cdot\ \right\}.$$

This form suggests that a first approximation of the form $\sqrt{2\pi}\left(\dfrac{n+\frac{1}{a}}{e}\right)^{\left\{n+\frac{1}{a}\right\}}$ might be made exceedingly accurate by choosing a in a suitable way.

Commencing in a similar way to that of Mr. Soper, we have

$$\log\left(n+\frac{1}{\alpha}\right)! - \log\left(n+\frac{1}{\alpha}-1\right)! = \log\left(n+\frac{1}{\alpha}\right),$$

where $n!$ is generally $\Gamma(n+1)$.

Now

$$\log\left(n+\frac{1}{\alpha}\right)! - \log\left(n+\frac{1}{\alpha}-1\right)! = e^{D/\alpha}(1-e^{-D})\log n!,$$

$$\therefore \log n! = \frac{e^{-D/\alpha}}{1-e^{-D}}\log\left(n+\frac{1}{\alpha}\right),$$

where D is the differential operator.

$$(1-e^{-D})^{-1} = \frac{1}{D}\left\{1+\frac{D}{2}+\frac{D^2}{12}-\frac{D^4}{720}\ \dots\right\},$$

$$e^{-D/\alpha}(1-e^{-D})^{-1} = \frac{1}{D}\left\{1+D\left(\frac{1}{2}-\frac{1}{\alpha}\right)+D^2\left(\frac{1}{12}+\frac{1}{2\alpha^2}-\frac{1}{2\alpha}\right)\right.$$

$$+D^3\left(-\frac{1}{3!}\frac{1}{\alpha^3}+\frac{1}{4}\cdot\frac{1}{\alpha^2}-\frac{1}{12\alpha}\right)$$

$$\left.+D^4\left(-\frac{1}{720}+\frac{1}{24\alpha^2}-\frac{1}{12\alpha^3}+\frac{1}{4!\,\alpha^4}\right)\dots\right\},$$

$$\frac{1}{D}\log\left(n+\frac{1}{\alpha}\right) = \left(n+\frac{1}{\alpha}\right)\left\{\log\left(n+\frac{1}{\alpha}\right)-1\right\},$$

$$D\log\left(n+\frac{1}{\alpha}\right) = \frac{1}{n+(1/\alpha)}.$$

. . . .

$$\therefore \log n! = \left(n+\frac{1}{\alpha}\right)\left\{\log\left(n+\frac{1}{\alpha}\right)-1\right\}+\left(\frac{1}{2}-\frac{1}{\alpha}\right)\log\left(n+\frac{1}{\alpha}\right)$$

$$+\frac{1}{2}\left(\frac{1}{6}+\frac{1-\alpha}{\alpha^2}\right)\frac{1}{\left\{n+\frac{1}{\alpha}\right\}}$$

$$+\left(\frac{1}{3!\,\alpha^3}-\frac{1}{4\alpha^2}+\frac{1}{12\alpha}\right)\frac{1}{\left\{n+\frac{1}{\alpha}\right\}^2}$$

$$+\left(-\frac{1}{360}+\frac{1}{12\alpha^2}-\frac{1}{6\alpha^3}+\frac{1}{12\alpha^4}\right)\frac{1}{\left\{n+\frac{1}{\alpha}\right\}^3}$$

+a constant,

i.e.

$$n! = \sqrt{2\pi}\left(\frac{n+(1/\alpha)}{e}\right)^{n+(1/\alpha)}\times\left(n+\frac{1}{\alpha}\right)^{(\alpha-2)/2\alpha}$$

$$\times\exp.\left[\frac{1/6+(1-\alpha)/\alpha^2}{2\{n+(1/\alpha)\}}+\dots\right]. \quad (1)$$

It will easily be seen that this reduces to Mr. Soper's form if α is taken to be equal to 2.

As a first approximation to the value of $n!$ we have

$$n! = \sqrt{2\pi}\left(\frac{n+(1/\alpha)}{e}\right)^{n+\frac{1}{\alpha}}\left(n+\frac{1}{\alpha}\right)^{(\alpha-2)/2\alpha}.$$

To make this the best possible first approximation, it is necessary to choose α so that the first term of the exponential series is zero, *i.e.*

$$\frac{1}{6}+\frac{1-\alpha}{\alpha^2}=0$$

is an equation for determining α, *i.e.*

$$\alpha^2-6\alpha+6=0.$$

The roots are $3\pm\sqrt{3}$ or 4·73205081 and 1·26794919. Approximately these roots are 19/4 and 5/4.

To decide which of these two values would be the better, the values of the coefficients of the next two terms of the exponential were determined for each value of α, and it was found that these values were practically of the same order of magnitude. I have chosen to take the lower value, because $\{n+(1/\alpha)\}$ will be greater for that value.

[At first it occurred to me that the desired result would be obtained by making the first term involving α in the exponential a minimum; but although a minimum it might be negatively large, so this criterion had to be ruled out. However, it was noticed that $\alpha=2$, which Mr. Soper uses, is practically the value of α which makes this term a minimum, especially for the larger values of n.

The condition for a minimum is that α should satisfy the equation

$$\alpha^2(6n+1)-12\alpha n-6=0,$$

i.e. α would be a function of n.

It is the positive root which concerns us, and it will be seen that as n increases this root tends to the value 2,

$$\alpha = 2+\frac{1-\frac{1}{4n}}{(6n+1)}, \text{ approx.}$$

Thus for the range of α values which makes the first term of the exponential negative, $\alpha=2$ is the worst possible choice in finding a good first approximation.]

Taking $\alpha=3-\sqrt{3}$, our series for $n!$ becomes

$$n! = \sqrt{2\pi}\left(\frac{n+b}{e}\right)^{n+b}(n+b)^{-c}$$

$$\times\left\{1-\frac{0{\cdot}0080{,}1875}{(n+b)^2}-\frac{0{\cdot}0004{,}6296}{(n+b)^3}\ \dots\right\}, \quad (2)$$

where $b=0{\cdot}7886{,}7513$, $b-c=\frac{1}{2}$, $c=0{\cdot}2886{,}7513$.

The value $\alpha=5/4$ was used in some calculations, and although the series then looks simpler, there is really nothing to be gained by taking this value; this is especially so for the computer who has a calculating machine. It will be noticed that our first approximation in (2) will be affected by an error of the order of $1/125n^2$ of its own value.

First approximation:

$$n! = \sqrt{2\pi}\left(\frac{n+b}{e}\right)^{n+b}(n+b)^{-c}. \quad . \quad . \quad (3)$$

This approximation was tested on a comparatively small value of n, $n=10$, $\log 10! = 6{\cdot}5597931$, *i.e.* $10! = 362{,}9051$.

Mr. Soper's first approximation $\sqrt{2\pi}\{(n+\frac{1}{2})/e\}^{n+\frac{1}{2}}$ gives $\log 10! = 6{\cdot}5614855$, *i.e.* $10! = 364{,}3221$.

The correct value is 362,8800; the error in the first case is only 251, while the error in the second is 14,421.

Extending the idea, we come to consider the Second Approximation. In the British Association Report for 1883, p. 407, Prof. A. R. Forsyth deduces a very pretty result for $n!$:

$$n! = \sqrt{2\pi}\left\{\frac{\sqrt{n^2+n+1/6}}{e}\right\}^{n+\frac{1}{2}}. \quad . \quad . \quad (4)$$

This compact result is obtained by a process which is essentially the same as the above, but applied to the second term of the exponential instead of the first. If we attempt to find α so that this term may be zero, it is necessary to solve a quartic in $1/\alpha(=x)$.

$$36x^4-24x^3-24x^2+12x+1=0.$$

[The term we are considering is

$$\left[\frac{1}{2}\left(\frac{1}{3\alpha^3}-\frac{1}{2\alpha^2}+\frac{1}{6\alpha}\right)+\frac{1}{2!}\left\{\frac{1}{2}\left(\frac{1}{6}+\frac{1-\alpha}{\alpha^2}\right)\right\}\right]\frac{1}{\left\{n+\frac{1}{\alpha}\right\}^2}.]$$

There are two positive roots, both between 0 and 1. The greater is the more suitable for our series. It is very nearly equal to unity and it was found to be very nearly 32/33.

As a second approximation $n!$ is then equal to

$$\sqrt{2\pi}\left(\frac{n+(1/a)}{e}\right)^{n+(1/a)}\left(n+\frac{1}{a}\right)^{(a-2)/2a}\left[1+\frac{1/6+(1-a)/a^2}{2\{n+(1/a)\}}\right], \quad (5)$$

where $1/a=32/33$.

From this expression, which is affected by an error of order $-1/360n^3$, $10!$ was calculated:

$10!=362,8806$ (an error of 6).

The approximation (4) gives

$10!=362,8787$ (an error of 13).

From the original value of a, the second approximation will be

$$n!=\sqrt{2\pi}\left(\frac{n+b}{e}\right)^{n+b}(n+b)^{-c}\left\{1-\frac{\cdot 0080,1875}{(n+b)^2}\right\}. \quad (6)$$

The error in this case will be less than $1/2000\times n^3$ of the whole.

(6) gives

$10!=362,8801$ (an error of 1).

Forsyth's approximation (4) has an error of order $1/240n^3$. It will be seen that the first approximation (3) is a remarkably good one, and the expression is quite good for calculation purposes. The value of $n!$ may be calculated in a very short time.

Mr. Soper's expansion, taken to the same order as (4), gives

$10!=362,8792$ (an error of 8),

with an error of order $1/400n^3$. The second approximation (6) derived in the same way as our first approximation is exceedingly accurate, and is better than that of (4); it is also better than Mr. Soper's, which in turn is better than Prof. Forsyth's (4).

Prof. K. Pearson has given in *Biometrika*, vol. vi., a very close approximation to the value of $n!$ This takes account of terms up to $1/n^4$ and partially of the term in $1/n^5$:

$$\log\frac{\Gamma(n+1)}{n^n e^{-n}}=0\cdot 3990899+\tfrac{1}{2}\log n + \cdot 080,929\sin\frac{25^\circ\cdot 623}{n}. \quad (7)$$

On evaluating $10!$ by means of this expression, it is found that the exact value is given to the nearest unit.

My chief aim in this note has been to show that a very good first approximation may be obtained without the use of any terms of the exponential and that the resulting expression is useful for computing factorials.

It may be of interest to give the values of 1! 2! and 10! found from these approximations in a single table:

	(3) of Present Note.	(4) Forsyth.	(7) Pearson.	Exact.
1!	1·00248	·99883	·99952	1·00000
2!	2·00266	1·99948	1·99996	2·00000
10!	362,9051	362,8784	362,8800	362,8800

JAMES HENDERSON.

Biometric Laboratory,
University College, London.

Dr. Kammerer's Alytes.

MAY I reply in a few words to Dr. Bateson's brief letter on Kammerer's Alytes, which appeared in NATURE of June 30?

Dr. Bateson states that when the nuptial callosities of genera allied to Alytes are described as appearing on the "inner" sides of the fingers, the word "inner" means the radial side and not the palmar surface.

This is quite true, but the callosity on the radial edge of the finger involves the palmar surface also, as Dr. Bateson may convince himself by inspecting Boulenger's figures, and as, indeed, is demonstrated to every student when he is shown the nuptial callosity of the male Rana.

Further, I learn from a letter from Dr. Kammerer that in the specimen of Alytes shown at the Linnean Society, the callosities extend round the radial edges of the fingers on to the dorsal surface, and that he would have demonstrated this to any one who had raised this point while he was explaining his specimens before the meeting.

Readers of NATURE are thus now in a position to judge what ground there was for Dr. Bateson's objections.

E. W. MACBRIDE.

Imperial College of Science,
South Kensington,
London, S.W.7, July 4.

Molecular Interruption.

IN reply to Mr. R. d'E. Atkinson's criticism (NATURE, March 10, p. 326) of my note on the possibility of selective molecular interruption, I should like to point out that so far from attempting to dispose of the validity of the ordinary treatment and claim the effect in question for "infinite free path," I had already shown (NATURE, July 22, vol. 110, p. 112) the reverse to be the case, and that such an effect is not then possible.

It is manifestly clear that it is illogical to conclude, however, because this is the case with "infinite free path" (*i.e.* in the absence of intermolecular collision in the system), that it must also be true for a system in which intermolecular collisions exist, with long free paths relative to the diameter of the directing vessel employed, the particular and special case alone dealt with in my note.

Mr. Atkinson's misinterpretation appears to have arisen from his overlooking my words "molecules issuing from collision in circle O," since his statement "all points on their long paths may equally be taken" as being in O is otherwise unintelligible.

His statement that I have admitted the length of the free path to be irrelevant is not correct. The excessive downward bias to which he refers is, in my opinion, due entirely to the fact that molecules proceeding from collisions (with equal probability of motion in all directions) are interrupted by the vessel before the end of their normal free path period, *when they are moving in certain specific directions*; and are uninterrupted throughout the whole of their normal flight, *when they are moving in other specific directions*: a selective redirection or elimination of the former class which must continuously be leaving a corresponding preponderance of the latter—a conclusion which more careful calculation confirms.

ARTHUR FAIRBOURNE.

King's College,
University of London,
Strand, W.C.2.

The Transport of Rocks.

MAY I ask Prof. Grenville A. J. Cole, through the medium of your columns, how far the authority for the statement that "the Portuguese stone . . . was brought in carracks round the Cape to build the jutting fort on the coral shore of Moçambique" (NATURE, March 17, p. 353) is to be regarded as trustworthy?

I first saw this fort in 1911, and as recently as September last year I walked all round it. I have never been inside, but I am told by Portuguese residents on the island that the same kind of stone has been used throughout in the construction of the fort. This stone is a sandy coral-rock, with occasional small pebble bands. The country rock of Moçambique island is also a coral rock identical in composition and fossil contents—so far as one can judge by hand specimens and very numerous exposures—with that of which the fort is built. This material occurs in vast quantities on the eastern coast of Africa, and indeed on many tropical coast belts: it is well seen at Mombasa and Zanzibar, which island, like that of Moçambique, consists of little else. The coral-rock is not the best material for constructional purposes, as an examination of the external walls of the fort is sufficient to show. Can it be that this material was shipped all round the Cape? It may be so, but I find it difficult to believe.

E. J. WAYLAND.

Fort Portal, Uganda, May 3.

IN reply to the interesting letter from Mr. Wayland of the Geological Department of Uganda, I beg to say that my authority for the statement that the fort of Moçambique was built of stone brought from Portugal is the uninitialled article in the "Encyclopædia Britannica," 11th ed., vol. 18, p. 949, where we read: "There are three forts, of which the principal, St. Sebastian, at the northern extremity of the island, was built in 1510 entirely of stone brought from Portugal."

I have examined the coral-rock here and at Mombasa, and, as Mr. Wayland states, it is not attractive for building purposes. I cannot speak as to the outer wall of the fort, and it may have been rebuilt or refaced since 1510. It would be interesting now to pursue the matter in some detailed history of Moçambique.

GRENVILLE A. J. COLE.

On Auroral Observations.

IT has been found that the green auroral line is regularly visible in the clear night sky, and Lord Rayleigh has discovered the remarkable fact that it is more intense at Terling than in the north of England. A cognate investigation, which, so far as I know, has not yet been made, may be suggested to auroral observers, namely, to examine how the intensity changes at any one place throughout the night. The observation is doubtless a difficult one, but might be made by exposing a series of plates at different hours on a succession of clear nights. It would be of great interest to know whether or not the intensity remains nearly uniform throughout the night hours.

S. CHAPMAN.

The University, Manchester,
July 4.

Gradient of Potential near Electrodes.

IN NATURE of March 31, p. 431, Messrs. H. Nagaoka and Y. Sugiura describe a method of observing the Stark effect in the iron arc; namely, in the thin layer at the surface of the lower electrode. This fact points to the existence of a considerable gradient of potential in this layer.

In the course of an investigation of the radiation in the spark I have found, by means of direct electric measurements, the existence of a considerable gradient of potential in the thin layer that surrounds the electrodes when the sparking discharge takes place.

The discharge of 952 sparks per sec., yielding an effective current of 24 milliamperes, shows that the change of the difference of potential depends upon the length of sparks, as the accompanying diagram (Fig. 1) shows. If the sparks are so short that the thin layers in the proximity of the electrodes, which yield a metallic spectrum, are not yet divided, then there exists a great gradient of potential (Fig. 1, I). The size of gradient depends first upon the nature of the metal forming the electrodes. This is shown by the two curves on the diagram for electrodes of platinum and aluminium.

At longer sparks, while among the above-mentioned layers only a spectrum of gas appears, the gradient of potential is much less (Fig. 1, II); this does not depend upon the nature of the electrodes.

The intermediate space, marked by interrupted lines, is difficult to examine. Sparks of both kinds generally come into view.

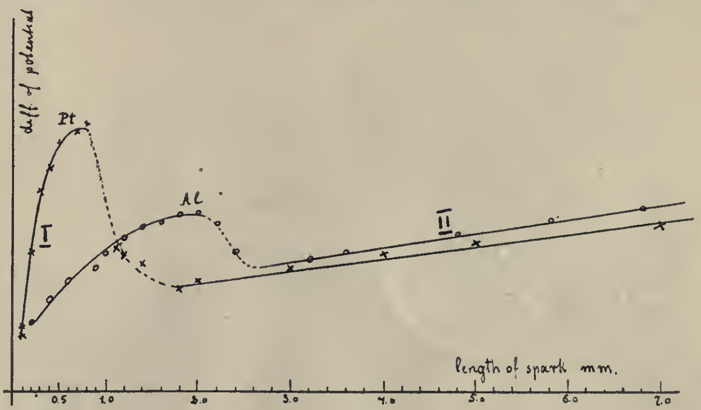

FIG. 1.

If V_1 signifies the difference of potential for short sparks, and V_2 that for long sparks, we get for platinum and aluminium electrodes about:

$$\left(\frac{\text{grad. } V_1}{\text{grad. } V_2}\right)_{Pt} = 10 \qquad \left(\frac{\text{grad. } V_1}{\text{grad. } V_2}\right)_{Al} = 5$$

The thickness x of the layer where there is a considerable gradient of potential is small:

Pt.	Cu.	Al.
$x = 0.4$	0.4-0.5	0.7-0.9 mm.

This investigation is being continued.

S. PIEŃKOWSKI.

Physical Institute,
University of Warsaw,
Hoza 69.

The Tides.

THE notice in NATURE of April 14, p. 508, of my pamphlet on the tides implies that I have completely misunderstood "the theory of the tide-generating force on the principle of gravitation." Regarding this I would like to present to your readers, very briefly, just one point in that theory: Newton, Herschel, and many other authorities compute the principal tide-raising force as the difference between the moon's attraction at the earth's centre and at the earth's surface. Now this is exactly the method

that would be employed if the sea were about 4000 miles deep. But the sea is only about 2 miles deep, in which, obviously, the tide would be practically insensible compared with that in a sea 4000 miles deep. The height of the tide is measured from the sea bottom; so that whatever elevation by tidal action of that bottom, which takes place, is not added to the height of the tide at all. Why, then, should the action of the tide-raising force beneath the bottom of the sea be added to that action within the sea itself (as is invariably done) to obtain, or explain, the ocean tide?

There are many other points of the tidal theory discussed in the pamphlet referred to which are equally difficult of explanation according to the theory of gravitation. To a statement of these difficulties it is really a rather unsatisfactory answer to say merely that their presentation betrays "a complete misunderstanding of the theory." Facts should be given to show of just what the misunderstanding consists; and truly such facts would not be a waste even of the columns of Nature, but would undoubtedly prove edifying to many of your readers besides the present writer.

The "Tides" pamphlet will be sent free on request to any one interested. Evan M'Lennan.

Corvallis, Oregon, U.S.A.,
May 26.

To any one who understands the theory of gravitation, Mr. M'Lennan's letter is a complete justification of the note. To those who would think that there might possibly be something in it, nothing less than chapter v. of Sir G. H. Darwin's popular book on tides would be of any use. There are too many important and pressing demands upon the space of Nature to permit a full discussion of the points put forward by Mr. M'Lennan. We can only remark that the tides are due to the difference between the response of the oceans and the solid earth to the attractions of the sun and moon. The motion of the solid earth as a whole is determined by the forces at its centre, so that the differential motion of the oceans is determined by the vectorial excess of the forces at the earth's surface over those at its centre. Of this excess it is the component *tangential* to the earth's surface which is effective in producing the tides. The Writer of the Note.

Barometric Pressure in High Latitudes.

In his letter (Nature, May 12, p. 634) on the subject of the causation of anticyclones, recently under discussion, Mr. R. M. Deeley makes two statements which cannot, on the most liberal interpretation of their face value, be reconciled with the real facts of the case as they are well known to meteorologists.

First of all he says: "Another clear effect of surface temperature is the fact that the North Pacific cyclone and the North Atlantic cyclone (the eyes of the North Polar cyclone) are more powerful during the summer than they are during the winter." This is in direct opposition to the truth, as any one will find who refers to charts of mean pressure for January and July, wherein he will find the Icelandic and Bering Sea minima greatly accentuated in winter and nearly obliterated in summer. Moreover, these mean or average charts are merely the generalised expression of one of the most obtrusive facts of seasonal climatology; namely, the frequently violent cyclonic mood of the North Atlantic ocean in mid-winter, and its generally much milder state at mid-summer, together with the many more gales we experience in England in December and January than in June and July.

Secondly, Mr. Deeley refers to "the striking facts that throughout the year the great low-pressure areas are over the frigid poles." Now though there may be relatively low pressure with cyclonic circulation at higher atmospheric levels round the poles, the modern work of Dr. G. C. Simpson for the Antarctic, and of Prof. Mohn for the Arctic, indicate that the *surface* pressure at both poles is relatively high, supplying an outflow of air towards the low pressure belts about latitudes 60° N. and S. In the Antarctic there is a true glacial anticyclone; in the Arctic the land areas round the polar basin complicate the distribution of pressure, but the pressure over that basin is relatively high throughout the year, particularly in winter, when it links the interior glacial anticyclone of Greenland with the continental anticyclone of Siberia.

Moreover, if the Polar Front theory of Prof. Bjerknes is true—and though there are justifiable doubts as to whether that theory is a full dynamical explanation of cyclonic circulation, no weather forecaster will dispute that it provides an excellent geographical background of reference for the facts associated with that circulation—there *must*, on the average, be relatively high surface pressure about the poles.

With regard to the effect of surface temperature on pressure it is quite true (as Mr. Deeley observes) that in the northern hemisphere, where there are such violent contrasts of continent and ocean, the continents command the excess of air in winter on account of the cold, but lose it to the oceans in summer on account of the heat. But this relationship between surface temperature and pressure is only very rough. There cannot be high or low pressure *everywhere*; and the actual result is a highly complicated regional compromise. If the northern hemisphere were all land or all water, there could not be those marked seasonal or monsoonal disturbances, so conspicuous on the January and July charts of mean pressure, of the simple dynamic belts of wind and pressure, namely, low at the equator, high at about 30° N. and S., low again at about 60° N. and S., high again at the poles, to which one gets an approximation on the annual chart and also on those for April and October. One must grant that the circulation of the atmosphere is initiated and maintained by the general thermal gradient between the equator and the poles; but the rotation of the earth and the seasonal contrasts of temperature between continents and oceans combine to impose an exceedingly complex structure upon the circulation. L. C. W. Bonacina.

27 Tanza Road, Hampstead, N.W.3,
June 14.

Ionisation Potentials of Copper and Silver.

In their book on "The Origin of Spectra" Foote and Mohler assign ionisation potentials of 7·692 and 7·542 to copper and silver. These are calculated from spectroscopic data. I have recently succeeded in obtaining low voltage arcs in the vapours of these two metals. For copper, a voltage of 7·8 was found, agreeing with the value given above as closely as one would expect from observations on a low voltage arc. For silver vapour, however, the value found and verified by many observations was 6·0 volts. There were indications of a resonance potential at about 3·1 volts.

This work is being continued especially into the spectroscopic region. A. G. Shenstone.

Physical Laboratory,
University of Toronto.

The Problem of Cancer.

ONCE again the public is being made to focus its attention on cancer through the activities of the recently constituted British Empire Cancer Campaign. The object of this so-called campaign is to collect large sums of money which will be devoted to the further study of this disease, which annually sweeps away about 40,000 people in England and Wales alone. The new campaign is taking place under the direction of a committee which has been described as influential, but we search in vain for evidence that the committee, as a whole, possesses the necessary qualifications to direct or to suggest research on what is admittedly one of the most difficult problems in biology. There can be no harm in raising money for medical research—it is, in fact, a highly praiseworthy object—but in the interests of those who have provided the money, it is essential that it should be used in the best way, and it does not appear that the new committee, composed largely of medical men practising among the political, wealthy, or aristocratic sections of the community, is a suitable one to direct cancer research.

The *raison d'être* of the new committee is indeed obscure, for there already exists an Imperial scheme—the Imperial Cancer Research Fund—which has been hard at work with the problem of cancer for twenty years. This committee is under the presidency of the Duke of Bedford, who, as a Fellow of the Royal Society and a man of science, has associated himself very closely and practically with the problem for many years. In addition to a large general committee of Imperial flavour, there is also an executive committee specially composed of men in the highest ranks of the profession, practical and scientific. The work of the Imperial Cancer Research Fund is universally admitted to be of a very high order, and, although it has not been possible to elucidate the cause or causes of malignant growths, a flood of light has been thrown and many foolish views have been exposed and confuted by the researches first of Bashford and later of Murray, who have been the scientific directors of the Imperial Cancer Research Fund. Their work has placed the Fund in the forefront of institutes devoted to the special study of cancer.

It is difficult to understand why a second cancer fund —also Imperial—should be started to do the same work as that which has already been admirably done by the first and older Imperial Cancer Research Fund. From several sides comment has been made on this apparent anachronism, and it has been suggested that, while the new campaign might collect money, its distribution should not be left in the hands of the new committee but should be dealt with by scientific bodies like the Royal Society or the Medical Research Council, acting alone or in co-operation with the Imperial Cancer Research Fund; for, after all, the problem is one of the most difficult now being studied in science.

The Position of Cancer Research.

The subject has passed beyond the realms of clinical observation, and clinicians do not possess the requisite education either to add to or even to supervise work which demands highly-trained biologists. It is, indeed, becoming more and more apparent that cancer is not merely a human problem but one of general biology.

There was a time when the word "tumour" was used to include almost every kind of abnormal swelling that was more or less circumscribed. A great many such swellings have now been separated off, as they have proved to be of inflammatory nature. Even among true tumours a distinction has been made into those that are benign and those that are malignant. Formerly tumours were classified according to their shape or consistence, and many terms employed in this period still prevail, although with an altered significance. Examples of this kind may be cited in such names as "fungus," "polypus," "encephaloid," and "sarcoma." Even the word "cancer" is derived from the supposed resemblance of the cut surface of the tumour to the spreading limbs of a crab.

Up to the first third of last century it was commonly held that cancers and suchlike tumours were something foreign to the body; but with the discovery of the cell, Theodore Schwann showed that there was nothing in any tumour that was really heterologous. His researches, continued by Lebert, were immensely extended by Virchow in his great work "Die krankhaften Geschwulste" (1863–67), to which but little has been added or subtracted from a purely pathological viewpoint. He showed that every tumour is the result of a tissue-forming function derived from the constituents of the body, and the real problem of tumour formation to-day is to find what starts this and causes the tissues to behave in an abnormal way. Every tumour represents a breach in the continuity of some tissue, so that, although arising in a tissue and due to the proliferation of that tissue, the new growth, tumour, or blastoma, as it is called, is really inimical to the well-being of the tissue. Its growth is progressive and unlimited. The cells of which every tumour is composed are bolshevistic, anarchical, or autonomous in varying degree. The laws that govern the behaviour of the cells of a tissue towards each other or other cells are violated. The tumour cells are in some mysterious way set free from restraining influences, and, having attained their liberty, behave in a riotous rather than an orderly manner. Although it is common to speak of cancer as something special, there is the same process at work in all tumours, but the degree of autonomy varies in each. If left to themselves, even the most innocent tumours grow progressively, and may become harmful in virtue of their magnitude. Some of the largest tumours known are benign in a clinical sense, while some of the smallest in point of size may be of deadly malignancy.

Basing the classification of tumours on their origin—histogenesis—Virchow separated them into three great classes according to their components. In his first group—simple histioid tumours—there was only one tissue, whereas in the second or organoid tumours two tissues were involved, one being connective tissue, the other epithelial. In his third group—teratoid tumours —the new growth was composed of several tissues arranged in organ-like fashion. Whatever starts the

cells off, the later growth of a tumour is due to the division of its cells. As this growth proceeds, one of two things happens. Either the tissues become pressed upon and flattened out so that the tumour is said to grow "expansively," or the tumour cells invade the other tissues, gradually destroying them, and finally insinuating or infiltrating themselves into lymph-vessels or blood-vessels. Thus they may be swept away and transported to the most remote ends of the circulation, where, being arrested, they again start to grow and produce a secondary or daughter tumour which is a copy more or less perfect of the primary growth.

It is this last peculiarity which compels us to place true tumours or blastomata in a class outside the swellings caused by inflammatory processes, even although the latter present a certain superficial resemblance to blastomata. The tumour cell itself is or carries the actual exciting agent to continued cell growth, and it is when we come to the question of the cause of this extraordinary cell growth that we are in Cimmerian darkness. We do not know whether there is one or many causes of new growths, and our methods of treatment, especially of the more autonomous or malignant growths, are hopelessly defective.

Theories of the Origin of Malignant Growths.

Naturally, various causes of malignant growths have been suggested, and three at least have been seriously studied; namely, irritation, the action of a parasite, and embryonic aberration.

(1) It is widely held that some irritation, physical or chemical, applied over a long period may incite the cells to unusual growth, which ultimately takes an abnormal blastomatous course. In the last few years, many experiments have concurred to show that tar products may be active incitors to tumours both in men and animals. Cancers in man are not infrequently to be seen in association with some chemical or infective irritation.

(2) A second current of thought has centred round the possibility that tumours, and especially cancers, are due to an exogenic parasite of some kind. From the structure of primary and secondary growths it is necessary to assume that if there is a parasite it must not only incite the cell to division, but also actually be intracellular, for the cells of a secondary distant tumour are the descendants of those that compose the primary tumour. For example, a cancer may arise from the liver. It is composed of liver cells; it may actually, although in an imperfect way, secrete bile. Such a tumour may be carried to the brain, and there we again find that the tumour is composed, not of brain but of liver cells, and it may actually produce bile. If such a tumour is due to a parasite the latter must be inside the tumour cells. Many attempts have been made to find parasites. It must be admitted, however, that up to the present no one has found a parasite in the cells of a tumour which produces a similar tumour in the homologous or heterologous species.

(3) The failure to find a parasite led to another theory—that tumours arise from some embryonic aberration. This view is associated with the names of Durante and Cohnheim, and in certain cases is undoubtedly to be accepted as the probable cause, if it is agreed that there is a high degree of specificity among cells. There is much reason to believe that cells retain their specific characters, or, as Bard has expressed it, "Omnis cellula e cellula ejusdem generis." If this is correct, as it appears to be, one can explain the occurrence of heterotopic tumours best upon an embryological basis. Thus the occurrence of a tress of hair, a tooth, a piece of cartilage, and fragments of lung or intestine in a dermoid tumour of the ovary of a virgin is explicable best on some embryological aberration. It is impossible to believe that the occurrence of 1000 teeth in a tumour of the jaw can be produced by a parasite.

While, however, Cohnheim's theory may explain some growths, there are others which do not come into this category. The degeneration of the process of growth, which is one of the main features of tumours, is evidently some very fundamental process, for growths benign and malignant are found in all animals from fish upwards. Although this fact does not explain the cause of cancer, it dispels many of the foolish theories which have been brought forward to explain cancer in man.

Up to the present time, the histological structure of tumours has been very extensively studied all over the world, but it is increasingly apparent that this method alone has great limitations. In consequence, it has given way to the study of malignant tumours which can be successfully transplanted from one animal to another of the same species. Many facts connected with the origin and spread of, and immunity to growths have been established by this kind of investigation.

In more recent times the physiological processes in cancer tissue have been investigated, as well as the production of malignant tumours in animals, by the application of chemical substances like tar or the chemical substances produced by the concurrent development in the animal of certain animal parasites, as was shown by the extended researches of Johannes Fibiger in Copenhagen.

Another line of work has concerned itself with the growth of tissues *in vitro*. It is probable that much light will be thrown upon the whole of the blastomatous processes by work of this kind. The field of cancer research in man is limited on account of the fact that he is outside the pale of experimental analysis. Methods of treatment may be tried to cure such a desperate disease, but it is reasonable to demand that there should first be some experimental basis for the treatment.

The main point, however, is that all over the world the highest class of scientific workers are busily engaged in trying to solve one of Nature's great mysteries which affects both man and almost all known animals. Cancer is a dreadful, inscrutable disease, and, however blunted medical men become from constant association with other diseases, they never become immune to the sufferings of the cancer patient. Although the main cause of the trouble is unsolved, it is not to be imagined that the research world is standing still. On the contrary, there is everywhere a pulsation which indicates that we are getting nearer the solution of the mystery.

W. B.

The Rotation of the Earth and its Influence on Optical Phenomena.[1]

By Prof. H. A. LORENTZ, For. Mem. R.S.

THERE are different ways in which, by means of optical phenomena, the motion of a system can be detected. I shall speak of them successively, with a view especially to the rotation of the earth, briefly considering also the optical effects that are due to the annual motion, which can be taken to be a translation.

1. DOPPLER'S PRINCIPLE.—In the first place there is Doppler's principle. If r is the distance from a luminous source to an observer (or to the slit of the spectroscope), $v_r = dr/dt$ the relative velocity in the direction of the line r, and n the real frequency of the light emitted by the source, the observed frequency will be $n+\delta n$, where

$$\delta n = -\frac{v_r}{c} n,$$

c being the velocity of light. The corresponding change of the wave-length λ is given by

$$\delta\lambda = \frac{v_r}{c}\lambda.$$

The velocity of the earth's translational motion is 30 km./sec., *i.e.* $\frac{1}{10000}c$. It can give rise for yellow light to a change in wave-length of about half an Ångström unit. The displacement of spectral lines produced by it is perfectly observable; in fact, star velocities of some 50 km./sec. are measured with a considerable precision.

If the observed shift of the spectral lines of a star is corrected for the motion of the earth, one finds the velocity of the star with respect to the sun. In the case of many spectroscopic binaries, the determination of the elements of their orbits would be wholly impossible if the motion of the earth were not taken into account.

The velocity of a point of the earth's surface due to the rotation is much smaller than the translational velocity. Even for a point on the equator, it amounts to no more than 0·46 km./sec. The displacement of a spectral line corresponding to this is, for yellow light, about 0·009 Å.U., 1/660 part of the distance between the D-lines. This can scarcely be observed. If it were somewhat greater, one would see that the lines in the solar spectrum lie somewhat more towards the violet at sunrise than at sunset. It must be remarked that the consequences which one draws from Doppler's principle would remain true whatever might be the state of motion existing in a medium surrounding the earth. The question only is whether two successive vibrations emitted by the source take equal or unequal times to reach the slit of the spectroscope.

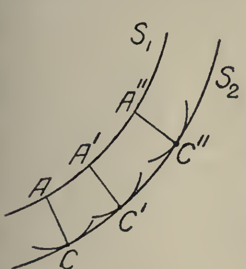

FIG. 1.

2. HUYGENS'S CONSTRUCTION.—In the second place, the propagation of waves and rays of light may be modified by a motion of the system, a modification that can be found by means of Huygens's construction. Let S_1 (Fig. 1) be the wave-front, *i.e.* the surface that is reached at a certain time t by a vibration emitted by the source at some previous instant. Then, around each point A, A′, A″ . . . of S_1 one can describe the elementary wave formed in a time dt. The surface S_2 tangential to them all will be the new position of the wave-front. The lines AC, A′C′, . . ., joining the centres of the elementary waves to the points where they are touched by S_2, are elements of rays, *i.e.* of the lines which determine the lateral limitation of beams of light. The velocity of a ray is given by

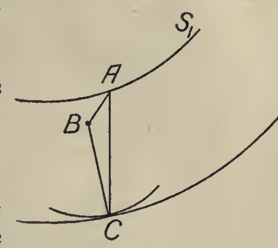

FIG. 2.

$$u = \frac{AC}{dt}, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and the course of a ray of light s between two given points A and B is determined by the condition that

$$\int \frac{ds}{u} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

is a minimum (Fermat's principle).

This general method can be applied to the case of ether moving through the diagram with respect to which one wants to know the propagation of light. The elementary wave around a point A (Fig. 2) is a sphere with radius cdt (c velocity of light in ether), but drifting along with the ether. The centre of the sphere will be at B, if AB is in the direction of the velocity v with which the ether moves across the diagram and has the length vdt. From the triangle ABC one finds, if θ is the angle BAC between the velocity of the ether and the ray AC, and if terms of the order $(v/c)^2$ are neglected,

$$\frac{ds}{u} = \frac{ds}{c} - \frac{v}{c^2}\cos\theta ds. \quad . \quad . \quad . \quad (3)$$

The figure also shows to what extent the ray AC deviates from the normal BC to the wave-front.

3. STOKES'S THEORY OF ABERRATION.—In this theory it is supposed that the ether is set in motion by the earth, like an incompressible fluid, the velocity of the ether at any point of the surface being equal to the velocity of the earth. At some point P just outside the region where there is an appreciable velocity of the ether, the light coming from some star S will have its wave-front at right angles to PS. The above construction gives the direction of the ray, *i.e.* the direction in which the star is observed; the result agrees exactly with that of the well-known elementary theory of aberration. Stokes further supposes that the motion of the ether is irrotational, so that v depends on a velocity potential. In this case (3) shows that (2) may be replaced by $(1/c)\int ds$ plus a term that is independent of the path; the ray of light is therefore a straight line, and the ordinary

[1] Lecture delivered at University College, University of London, on May 17.

theory of aberration not only holds for the point P, but also for the point where the ray reaches the surface of the earth.

Stokes's theory cannot, however, be maintained, because the two assumptions that there is a velocity potential and that all over the surface the ether has the velocity of the earth contradict each other.

4. Ether Whirls.—It can be imagined that a rotating planet is surrounded by a whirl in the ether. If definite assumptions are made concerning the distribution of velocity in this whirl, one can determine the deviation of a ray passing through it and the amount of diurnal aberration thus produced.

There is another phenomenon still by which one could detect an ether whirl. If the planet Jupiter were surrounded by a whirl, there would be a deviation that could be observed in the case of the occultation of a star, and that is found to be quite appreciable if plausible assumptions concerning the extension of the whirl be made. Nothing of the kind has ever been observed. This speaks in favour of the hypothesis that the ether is not set in motion by the planet.

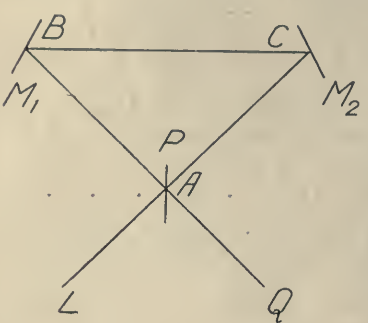

Fig. 3.

5. Fresnel's Theory of Aberration.—Fresnel assumed that the earth is absolutely permeable to the ether, so that it can pass through the ether without in the least setting it in motion. So far as the subject of this lecture is concerned, this assumption leads to the same results as the theory of relativity. The annual aberration is now immediately explained by what was said in § 3. As to the daily aberration, it is determined in the same way as the annual aberration by the motion of the observer. If an astronomer placed at a point on the equator observes a star situated in the plane of that circle, at an altitude h, the aberration amounts to $0{\cdot}32'' \times \sin h$. It would be possible to observe it if the distance of two stars far apart could be measured to within $0{\cdot}1''$. If, for example, two stars A and B in the plane of the equator follow each other in their daily motion at a distance of 60°, their distance will be diminished by $0{\cdot}16''$ when A has reached the zenith, and increased by the same amount when B has reached that point. In reality, however, the existence of the diurnal aberration has not been proved, though astronomers correct their observations for it.

6. Michelson's Interference Experiment.—Prof. Michelson has devised an experiment in which two rays of light propagated in opposite directions along the sides of a great triangle ABC (Fig. 3) in a horizontal plane are made to interfere; M_1, M_2 are mirrors, P a dividing plate of glass; the course of one ray is LACBAQ, and of the other LABCAQ.

In general, let L and Q be any two points having a fixed position in the figure, which is attached to the earth. The ether (supposed not to share the earth's rotation) has a motion through the diagram, consisting in a rotation about the axis of the earth. From what has been said in § 2, one can deduce the time that is required for the passage from L to Q. Let s be the course of the ray if there were no rotation, s' the actual course. One has to calculate the value of (2) for s', but if one neglects terms of the second order, one can substitute for it the value for the path s, because the integral is a minimum for s'. The influence of the earth's rotation is given by the integral of the last term in (3), and is found in the case of Fig. 3 to be proportional to the area of the triangle ABC, to the angular velocity of the earth, and to the sine of the geographical latitude. The effect would be of equal magnitude but of opposite sign for the two interfering rays, and so the position of the interference fringes will be slightly changed by the rotation of the earth. It may be hoped that it will be possible to observe the effect by a suitable method of observation.

7. An Imaginary Experiment.—Suppose two parallel metallic wires (perfect conductors), such as are used in Lecher's experiment, to be placed round the equator of the earth, each forming a closed circle. Let standing electromagnetic waves be produced between these wires. One may confidently expect that the loops and nodes will travel around the earth from east to west in 24 hours, and this can be considered to be a proof of the earth's rotation.

If the statement that the earth rotates is to have any meaning one must assign some system relatively to which the rotation takes place. If the imaginary experiment were performed with the result just mentioned, one could say that the earth rotates (1) relatively to the loops and nodes, (2) relatively to a system of co-ordinates in which light is propagated in straight lines with the speed c, (3) with respect to the stationary ether in which the loops and nodes have their seats, or (4) with respect to the fixed stars by the influence of which the position of the loops and nodes is determined. (Mach, Einstein.)

A Large Refractor for Johannesburg.

By Frank Robbins.

Twenty years ago, and soon after the close of the Boer War, the South African Association for the Advancement of Science petitioned the Transvaal Government for the establishment of an observatory for the sciences of meteorology and astronomy. The reply was immediately favourable as regards meteorology, but it was not found possible to organise an astronomical department for some half-dozen years or so. In the meantime, by loan or by gift, a few instruments were obtained, and quite soon attention was forcibly directed to the very exceptional climate and sky of Johannesburg by means of work actually done there by the aid of a modest 9-inch refractor. In consequence, early in 1909 the Minister for Lands

made provision in his estimates for the erection of a visual refractor of 26 inches clear aperture, and a contract with Sir Howard Grubb and Sons, Ltd. was signed in November of that year. Discs for the objective were ordered at once from France, but the production of optical glass of that size is a slow and uncertain process, and in 1912 efforts were made to obtain a supply from Messrs. Chance Bros. and Co., Ltd., of Smethwick, near Birmingham.

Trials and disappointments followed, parallel and in series too. At this time Sir David Gill, the designer of the telescope, had inspected the equatorial and reported "Nearly complete and exceedingly satisfactory"—this was in the summer of 1912. There followed two years full of hope passed in fresh efforts and experiments. Then the Great War put a stop to everything. . . . The Armistice came at last, and when the smoke of battle cleared away it was found that the Admiralty had silently transferred Sir Howard Grubb's workshops from Rathmines, near Dublin, to St. Albans, and there in the confused heaps of material, tools, patterns, periscopes, range-finders, and waste, lying on the new workshop floors, it was said the famous telescope was lying dismembered and for the most part unrecognisable.

It was necessary to start again, not quite from the beginning but very nearly so, and this necessitated conferences, new estimates, and references to Pretoria, but finally order arose out of chaos. Fresh contracts were made in November 1922, and in the following March Messrs. Chance Bros. reported complete success. On their invitation a few astronomers journeyed to Birmingham to view these long-desired discs, and there the visitors experienced moments, nay minutes of tension. The room containing this precious optical glass proved unsuitable for the examination, so two workmen carried the flint disc weighing some 240 lbs. in their four bare hands through a narrow doorway across an uneven floor, wending their way between great blocks of glass into another room. Perhaps it was not as dangerous as it looked, but to the interested spectators it seemed a passage perilous, where the labour of thirteen years might have been lost by an unlucky step.

These two discs, when tested for striæ and annealing, satisfied the optical expert, and they were taken to St. Albans, where the rough grinding of the flint is proceeding as shown in Fig. 1. To the objective it is intended to give the form now generally familiar to astronomers: a double convex crown fronts the stars and is followed at a distance of some six inches by a double concave flint, the fourth surface being of extremely long radius. In its mounting a close-fitting sliding band will make it possible to clean either or both the inner surfaces, and here it has been essential to pay special attention to the complete exclusion of dust, of which Johannesburg easily obtains its share. The rough discs measured $26\frac{3}{4}$ inches, and are to yield a finished objective of 26 inches clear, with a focal length of, say, 35 feet, giving a ratio just over 16.

The dome for the telescope has been ready and in position for so long that its appearance in any photograph of the outskirts of Johannesburg must be quite familiar to many. A good photograph of the whole instrument on its equatorial as it stands in Fleet Works, St. Albans, cannot be obtained, and yet it is probably the most frequently photographed telescope in the eastern hemisphere; since Christmas last, views of it have appeared in two of London's leading newspapers, but each time it has been ascribed to Russia, and on the first occasion it was even described as the largest telescope in the world.

Fig. 2 shows the view from the south-west of the heavy castings for the stand with the polar axis carrying the right ascension circle at its lower (north) end. Most of the tube is visible, with its central cube and the extension for the counterpoise. Fig. 3 is the breech-piece with photographic plate-holder. It shows also the 4-inch finder of 60 inches focal length. This is provided with either a variable bright field or with bright wires as desired for the particular work in hand. Several of the circular weights are to be seen the removal of which will make it possible to fit a spectrograph if it is so desired at any time in the future. These weights equal in all 370 lbs. The motive power for the driving clock is a weight which falls a quarter of an inch every ten seconds—the rewinding is automatic and electric. The weight of the moving parts amounts to more than five tons, but the roller bearings supplied and the carefully equal distribution of the mass make it easy for the observer to shift this load with one hand.

Fig. 1.—Flint disc.

The process of finding a faint star with this instrument is not quite as ordinarily obtains — it is more simple. The declination clamp is released, and the required declination reading is obtained; the instrument is then re-clamped. Now, because the right ascension circle is clock-driven, it constantly indicates

the local sidereal time. The right ascension clamp is released and the telescope shifted until the reading microscope shows the right ascension of the star. The right ascension is then clamped and the dome the quick motion in right ascension. The slow motion is controlled by the observer alone, who also holds in his hand means of adjusting the clock rate. Both co-ordinates of a star are read very easily from the eye

FIG. 2.—Equatorial with steel tube.

opened. The rising floor has a range of twelve vertical feet—it is not circular, and in azimuth it extends over 120° but always opposite the dome opening; for example, end, where there is a choice of three breech-pieces—one visual with four oculars, a second with a Repsold micrometer, and a third the photographic, made by

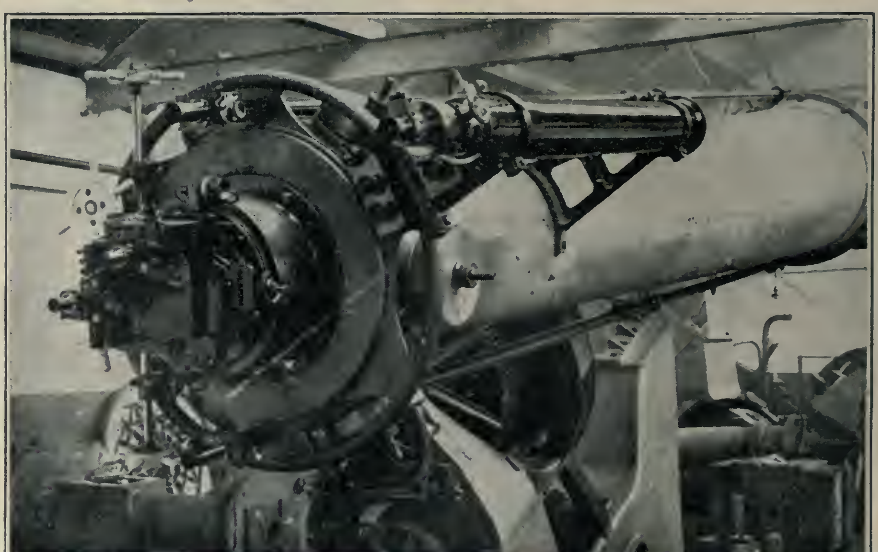

FIG. 3.—Eye-end 26-inch refractor.

when the telescope is pointing to N. 270° E. the rising floor or platform lies between N. 30° E. and N. 150° E. Observers being scarce, provision is made to save them from walking over the edge. In actual work an assistant will stand at the north end of the base and in charge of Adam Hilger to a specification and design by Sir David Gill. No digging for a foundation is required; the pier will be bolted directly to an outcrop of solid rock.

It remains to add a few words on the environment of this much-needed addition to the meagre list of large

telescopes south of the equator. Every one has heard of the Witwatersrand as the source of much of our gold. This range of hills lies in latitude 26° 11′ south, just north of Johannesburg, and here, at an altitude of 5925 feet, a thousand miles from Cape Town, and 240 miles from the sea, is the observatory. Antares is four minutes of arc south of the zenith, and is the only clock star required. The average height of the barometer is 24·35 ins.—one-sixth of the atmosphere is below and the part remaining is here less subject to vagary than in almost any other part of the habitable globe. The climate is remarkably sunny, and the sky is free from cloud to a very high degree. Astronomical observations are possible on 300 or more nights in each year; on 200 of these one could observe for ten hours continuously.

Think what this means; work can be planned months ahead with a certain assurance of favourable skies. There are no nights wasted watching for a possible break in the clouds, which, coming, is gone before it can be utilised, but good observing weather in quantity, the incidence of which can be predicted 99 times out of a 100. Cloudiness on the average equals 30 per cent., and even in the rainy season seldom exceeds 44 or 46 per cent. Humidity for the year is 57 per cent., January 71 per cent., July 42 per cent. Rainfall 25 to 30 inches, but there are only 85 wet days and not more than 190 wet hours. Of course there is a drawback: high easterly winds with dust; and such dust—clouds of it, equal in density to a fog, but not more than two or three days in a year are as bad as this. The seeing is exceptional—not optically perfect perhaps, but so nearly ideal that the fame of its quality is spreading abroad, and rumours are heard of northern observers intending to enlarge and complete their researches by a sojourn in the Union of South Africa.

Current Topics and Events.

WE have on several occasions expressed regret that no provision seemed to have been made for the display of achievements of pure science and their relation to industrial and Imperial development at the British Empire Exhibition to be held next year. We are glad, however, now to be able to announce that at the request of the Exhibition authorities the Council of the Royal Society has appointed a Committee to organise a central exhibit to illustrate the fundamental principles of certain departments of pure science, with special reference to the share taken in developing those principles by the Empire. A small sum of money has been placed at the disposal of the Committee and space allotted in the Central Pavilion. The Committee, which is a strong one, represents all branches of science. Sir Richard Glazebrook is chairman, with Sir Herbert Jackson and Mr. F. E. Smith as vice-chairmen. Mr. Woolcock, the chairman of the Association of British Chemical Manufacturers, who is taking the leading part in the organisation of the chemical exhibit, has become a member of the Committee.

THE Empire Cotton Growing Corporation has recently been considering the necessity for organised research at the universities and colleges of Great Britain, and has decided to offer retaining grants to certain universities where highly specialised research is already going on. The Imperial College of Science and Technology, South Kensington, has accordingly been offered the sum of 1000*l.* a year for a period of five years from October 1, the money to be devoted to plant physiology and plant pathology in the Department of Botany. The research work will be undertaken in the new Botany Building, recently opened by the Duke of Devonshire, to which the Rubber Growers' Association of the City of London subscribed about 30,000*l.* about two years ago. These gifts are tangible evidence of the value which tropical agriculturists attach to the important research work which is being undertaken at the Imperial College, especially in connexion with plant physiology and pathology, under the direction of Profs. J. B. Farmer and V. H. Blackman.

JULY this year has established a weather record for temperature, and in many places the thermometer has exceeded records for many years past, not only for July but also for any part of the summer. The hot spell was fairly established on July 5, when at Kensington and Greenwich the sheltered thermometer rose to 84° F. On July 6 the temperature at Kensington was 87° F., and at many health resorts it was 85° F. At Greenwich on July 7 the thermometer in the shade registered 90° F., and the solar radiation temperature was 163° F. The severe thunderstorms and torrential rains so prevalent over the country on July 9 and 10 had little effect in reducing the temperature, and from July 11 the heat became more intense. On July 12 the thermometer at Andover registered 94° F., and on July 12 and 13 the temperature at Kensington was 92° F., while the minimum night temperature registered on both mornings was 68° F. At Bath on July 12 and 13 the thermometer registered 93° F. and 92° F. respectively. On the night of July 12-13 the minimum temperature was 71° F. at Hastings and Brighton. At Kew the maximum temperature was 80° F. or above for ten consecutive days, and 91° F. recorded on July 13 is a record for July; while on the same day 96° F. at Camden Square is the highest temperature reported to the Meteorological Office during the warm spell. These temperatures fall somewhat short of the London readings during the abnormal summer of 1911, when 100° F. was recorded at Greenwich and 95° F. at Kew on August 9. A new type of pressure distribution set in over the British Isles on July 14, and a drop of temperature occurred in most parts of the country.

THE following elections to Beit Memorial Fellowships for Medical Research have been made, the general subject and place of research being given after each name:—*Senior Fellowship*: Dr. D. Keilin: the life-history of parasitic Protista and the physiology of parasitic Metazoa, at the Molteno Institute for Research in Parasitology, University of Cambridge. *Fourth Year Fellowship*: Dr. Katherine H. Coward: the processes of metabolism, nutrition and growth of

young animals, particularly with reference to the so-called deficiency diseases such as rickets, at the Biochemical Laboratory, Institute of Physiology, University College, University of London. *Junior Fellowships*: Dr. J. M. H. Campbell: Oxygen consumption and pulmonary ventilation during and after work in chronic heart and lung disease; total metabolism and "efficiency" of work in these and other diseased conditions; changes in the capillary circulation in the skin in certain chronic nervous diseases, at the Department of Physiology, Guy's Hospital, London. Mr. C. G. Lambie: Influence of insulin upon fat and protein metabolism; observations upon the fate of the sugar which disappears from the blood in hypoglycæmia produced by insulin, at the University of Edinburgh. Mr. W. K. Slater: Determination of the molecular weight and heat of combustion of glycogen; an investigation of cell mechanism under anaerobic conditions, in the Physiological Laboratory, University of Manchester, and the Institute of Physiology, University College, London. Miss D. S. Russell: The relation of renal efficiency tests to the morbid anatomy and histology of kidneys, at the Pathological Institute of the London Hospital. Mr. C. P. Stewart: Investigation of the methods of isolation and chemical constitution of thyroxin; the liver perfusion of substances related to histidine, in the Department of Medical Chemistry, University of Edinburgh. Mr. H. J. Channon: The study of certain fundamental dietary factors in the nutrition of living organisms, at the Institute of Physiology, University College, London. Mr. W. Smith and Mr. L. B. Winter: Investigations on general metabolism in health and disease, with special reference to the metabolism of carbohydrates; search for alternative sources of insulin, notably from yeast, at the Biochemical Laboratory, University of Cambridge. Miss D. B. Steabben: Investigation of the mechanism of response to injection of colloidal substances, at the Lister Institute of Preventive Medicine, Chelsea Gardens, S.W., and King's College (London) Physiological Laboratory. Mr. C. S. Hicks: Investigation of the causation of goitre from a biochemical point of view, such as a close examination of the relationship of iodine in foods to the incidence of goitre; the chemistry and pharmacology of substituents in the thyroxin molecule, from the point of view of the physiological action of thyroxin, at the Balfour Laboratory, University of Cambridge.

The Court of the Salters' Company has appointed Prof. A. Smithells to be director of the Salters' Institute of Industrial Chemistry.

We regret to announce the death on July 15 of Sir Henry Hoyle Howorth, F.R.S., a trustee of the British Museum since 1899, at the age of eighty-one.

The diamond jubilee meeting of the British Pharmaceutical Conference and a meeting of the International Pharmaceutical Federation will be held in London on July 23-27.

The Royal Danish Academy at its last annual meeting elected the following honorary foreign members: Prof. Albert v. Le Coq, of Berlin, Profs. Charlier, J. Forssman, and C. M. First, of Lund, Dr. F. A. Bather, of the British Museum, and Prof. F. O. Bower, of Glasgow.

At a recent meeting of the Institution of Electrical Engineers the following officers were elected:—*President*: Dr. A. Russell; *Vice-President*: Sir James Devonshire; *Hon. Treasurer*: Mr. P. D. Tuckett; *Ordinary Members of Council*: Mr. J. M. Donaldson, Dr. W. M. Thornton, Colonel T. F. Purves, Mr. G. W. Partridge, Mr. P. Rosling, and Mr. S. W. Melsom.

It is announced in *Science* that on his retirement through ill-health from the directorship of the Mount Wilson Observatory Dr. G. E. Hale has been appointed honorary director. Dr. Hale will remain in charge of the general policy of the observatory, and Dr. W. S. Adams, at present assistant- and acting-director, has been appointed director in charge of operations.

At a quarterly meeting of the council of the Royal College of Surgeons of England, held on July 12, Sir John Bland Sutton was elected president and Sir Berkeley Moynihan and Mr. H. J. Waring were elected vice-presidents for the ensuing year. Among the elections made were the following: Mr. H. E. Griffiths, Mr. V. B. Negus, and Mr. C. P. G. Wakeley to be Arris and Gale lecturers, Prof. S. G. Shattock to be Erasmus Wilson lecturer, and Sir Arthur Keith to be Arnott demonstrator.

The Minister of Agriculture and Fisheries has appointed the following departmental committee to inquire into the operations of the Fertilisers and Feeding Stuffs Act, 1906: Lord Clinton (Chairman), Mr. E. Richards Bolton, Mr. E. G. Haygarth Brown, Dr. Charles Crowther, Mr. T. Kyle, Mr. B. S. Miller, Mr. G. Stubbs, Dr. J. F. Tocher, and Dr. J. A. Voelcker. The committee is to advise whether any, and if so what, amendments are necessary in order to render the execution of the Act more economical and effective, and to report accordingly. Mr. H. J. Johns, of the Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W., has been appointed secretary to the committee.

Among the subjects discussed at the recent International Navigation Congress at Westminster on July 2–6 were the latest improvements in regard to signalling at sea and on the coast. Fourteen reports were submitted to the Congress, covering the current practice in Great Britain, Belgium, France, Holland, Italy, Japan, Russia, Spain, Sweden, and the United States. Reference was made to experiments carried out by Trinity House, in 1921, in connexion with synchronous signalling, in which two types of sound-transmitters were used—one a standard submarine bell, and the other a Fessenden oscillator, in conjunction with a wireless transmitter. The signals received from these were of such a character as to enable the distance to be calculated of objects invisible in fog, but within submarine sound range. A wireless installation, lately erected at Inchkeith in Scotland, was mentioned as affording facilities for experimenting with direction messages to vessels equipped with a simple type of receiver gear. The most important advance in light-

house work in the United States has been the establishment of radio fog signals. A plea was entered for the international adoption of some system of underwater signals, by which vessels in an area of reduced visibility could transmit information as to their courses to other vessels in the vicinity, as well as obtain the bearings of such vessels. The radio compass and position-finder now enable ships to approach the coast in thick weather. It remains to provide means to ensure the safety of vessels coasting and entering port. The feeling was expressed that the subject of marine signalling was so important as to claim a larger share of the time of the next Congress.

On July 4 Professor Dr. Ernst Beckmann completed his seventieth year. He was an apothecary originally, and changed over to the study of chemistry in 1875 under Kolbe in Leipzig. After a short stay at the Technical Highschool in Braunschweig he went to the University of Leipzig in 1884, where he worked first with Johannes Wislicenus and later with Wilhelm Ostwald. It was about this time that Beckmann made the observation that ketoximes are transformed by pentachloride of phosphorus into acid amides. This Beckmann transformation has shown itself to be a very productive reaction for the investigation of the stereo-isomeric nitrogen compounds. At the same time Beckmann elaborated the well-known methods for the determination of molecular weights by observation of lowering of the freezing point and rise of the boiling point of solutions. The use of Beckmann's apparatus is now widespread, as well as the Beckmann thermometer employed in these operations, which combines accuracy to one-thousandth of a degree Centigrade with a very simple regulation for the most varied ranges of temperatures. After having been for a short time at the universities of Giessen and Erlangen, Beckmann returned to Leipzig in 1897, and remained there as director of the laboratory for applied chemistry until 1912. During this time he showed great activity in numerous investigations in pure chemistry, foodstuffs, and drugs; further, he constructed the burners fitted with sprays which allow of continuous working with coloured flames for spectroscopic and other optical work. In 1912, Beckmann undertook the organisation of the newly founded Emperor William Institute for Chemistry in Dahlem, where Willstätter, Stock, O. Hahn, and Lise Meitner have done much of their work. He resigned from the directorship of this institute in 1921, but is still untiring in research and literary work.

The rise and growth of scientific and technical journalism is one of the most characteristic features of modern civilisation. Some day the upward trend of this movement must show a flattening tendency; but of the approach to this phase there is at present little evidence. The "List of Serials received in the Library of the U.S. Department of Agriculture" (Washington: Government Printing Office), exclusive of U.S. Government and State Agricultural College and Experiment Station Publications, which has recently been received, includes no less than 5586 distinct serials. If the excluded serials were added o the above figure and the publications currently received by the U.S. Weather Bureau were also thrown in, a grand total of at least 7000 serials would be recorded. All these serials, of course, are not exclusively devoted to agriculture, but they have, at any rate, been collected with the view of the furtherance of the work of the Department. As regards the purely agricultural serials, the list is practically a bibliography of the subject. The auxiliary sciences are adequately but less completely represented. The list, which is an 8vo volume comprising 358 pages, is divided into four parts. Parts 1 and 2 form a register of the entire collection. Part 3 is an admirably compiled subject classification of the serials set forth in parts 1 and 2. This part includes the U.S. Government and State publications. Part 4 is a regional distribution of the data contained in parts 1 and 2. The list is admirably compiled and clearly printed. The librarians of the Department are to be congratulated upon its production.

Referring to Dr. J. S. Owens' letter in Nature of June 23, p. 848, regarding the haze overlying southern England on Derby Day, Mr. F. R. Farquharson states that he made an exposure on the course, using the widest aperture of the lens on a Kodak film, when the horses suddenly appeared out of the mist barely a hundred yards away. The result when developed showed over-exposure, thus proving that the mist had not that light-stopping power common to the normal London mist. Dr. J. S. Owens writes: "The obstruction caused by a haze depends not only on its density but also on the length of path of the light through the haze. The distance between camera and object was short and thus obstruction correspondingly small, while it is probable also that the vertical thickness of the haze was small and thus plenty of light penetrated. Anti-cyclonic weather, which is often accompanied by an inversion of temperature gradient a little above the ground, provides suitable conditions for a shallow dust haze. The dust being unable to penetrate the 'lid' formed by the temperature inversion, may travel for great distances along the ground obstructing visibility of objects at a distance, but having little effect on the quantity of light reaching the ground from the sky. In a London smoke fog both the number of particles per c.c. and their size are usually greater, while the thickness of the layer of fogs is probably also much greater than in a haze such as that on Derby Day."

Mr. T. H. Digges La Touche, who is so well known by his published work in connexion with the Geological Survey of India, has prepared the catalogue and subject-index of literature added to the library of the Geological Society of London during the years 1915–1919. This volume of 545 closely printed pages fills the gap in the valuable lists issued by the Society, which are now complete to the end of 1922. Its price (10s.) is moderate, and for libraries the collection of the records for several years into one continuous series facilitates reference. The subject-index, occupying half the volume, is a monument to the careful reading and judgment of Mr. Digges La Touche, and it must be remembered that, for the period named, the work represents very fairly the

geological literature of the world. We cannot find here lists of the publications of geological surveys; these are indexed under their authors and the districts with which the memoirs deal. Maps separately issued are not regarded as "literature"; but, under the heading "Maps," there is a very useful list of those included, and often concealed, in printed papers, with indications of their scales.

In connexion with the mechanism whereby pollen is able to induce hay fever, a correspondent has suggested that possibly the pollen grains in the presence of moisture on the mucous membranes might protrude their pollen tubes; these might penetrate the mucous membrane. A view somewhat similar was developed by Blackley half a century ago in his famous "Experimental researches on the causes and nature of Catarrhus aestivus." He showed that neither the size nor the nature of the covering of the pollen can be the essential cause of hay fever, but from prolonged observations he believed that the moisture on the mucous membrane might cause the pollen to swell and to protrude its tube into a mucous gland. While this might explain some of the initial phenomena in an attack of hay fever, he was strongly of opinion that the obnoxious element of pollen was the granular matter in the centre, a view universally accepted to-day.

Our Astronomical Column.

Large Meteor.—In strong twilight on the evening of July 11 a fine meteor was seen at $9^h\ 9^m$ G.M.T., by Mr. E. W. Barlow of Wadhurst, Sussex, who considered the object as bright as Venus at its best. The nucleus was pear-shaped and bluish, and a red train followed it along an arc of about 10°. The duration of flight was 4 seconds and the path from 95 Herculis to η Ophiuchi.

Mr. E. H. Smith of Hanwell, W., also saw the object and describes the path with reference to the stars Altair and Antares. The height of the meteor was about 66-54 miles over the English Channel; length of path 90 miles, and velocity about 22 miles per second.

The fireball was also observed by the Astronomer Royal and by Dr. Crommelin at the Royal Observatory, Greenwich, and they give the azimuth of the end point as 15° W. of south.

The Spiral Nebulæ as Dust-Clouds.—Mr. J. H. Reynolds discusses in Mon. Not. R.A.S. for May the recent suggestion of Prof. Lindemann that the spirals are dust-clouds expelled from the Galactic system by radiation pressure, and shining by reflected starlight. He gives a diagram of the distribution of the spirals, and of their radial velocities, determined by Prof. Slipher. The data as regards size, inclination, and radial velocity appear to fit in fairly well with Lindemann's theory, if one adopts the eccentric position of the sun in the Galaxy, as given by Prof. Shapley's determination of the distances of globular clusters. The spirals nearest to the Galactic centre would have the highest velocities, but would appear small to us, owing to distance. Those nearest to us would appear large, but would have small radial velocities, their motion being nearly across the line of sight. There is one feature of the spirals, however, that Mr. Reynolds regards as negativing the theory of their shining by reflected starlight. This is the dark absorption stripe which is seen to cross the centre of many of the spirals that are seen nearly edgewise. On the reflection hypothesis, this should be bright and not dark; its presence seems to prove that the illumination of the spirals comes from within them. Some years ago Mr. Reynolds put forward the view that the spirals were shining by reflecting the light of some bright body in their centre, basing this on measures of the relative brightness of different regions. He now repeats this suggestion, and adds that it may be possible for the condensed matter in the middle of the spiral to give a spectrum of type F or G, without being in a stellar state. He quotes in support some recent experiments on the spectra given by exploded wires.

Stars in the Milky Way and at the Galactic Pole.—The Harvard College Circ. No. 242 contains a very interesting comparison of a Milky Way field with one at the South Galactic Pole made by Mr. Solon I. Bailey. The aim of such investigations is not only to give an estimate of the total number of stars that exist or rather can be photographed, but also to form an idea of their distribution in space. Star gauges were made by the Herschels a century ago, but since then studies of the distributions of stars have been completed by Argelander, Seeliger, Pickering, Celoria, Kapteyn, Chapman and Melotte, and others. It was generally deduced that there were only twice as many stars in the Milky Way as elsewhere up to about magnitude ten, although Herschel's counts gave a maximum of about 20 times as many stars in the Galaxy as at the Galactic poles. An increasing Galactic concentration with decreasing apparent brightness was shown by Kapteyn, and a similar but less rapid degree of concentration was deduced by Chapman and Melotte. Mr. Bailey discusses photographs taken with the 24-inch Bruce photographic telescope at Arequipa, Peru, the longest exposures showing stars fainter than the nineteenth magnitude. He gives a very instructive table indicating the relation of length of exposure to limiting magnitudes photographed, showing that as the stars become fainter, longer and longer exposures have to be made to gain every extra magnitude. Selecting a square degree area in Sagittarius in the Galaxy, one of the richest star fields of the Milky Way, and comparing this with the similar area at the South Galactic Pole, he obtains the following counts:

Exposures. m.	s.	Limiting Magnitudes.	Number of Stars. Galaxy.	Pole.	Ratio.
0	1	10·1	13	5	2·6
0	3·3	11·2	47	13	3·6
0	10	12·4	111	29	3·8
0	30	13·5	349	62	5·6
1	29	14·6	1,945	104	18·7
4	27	15·6	9,160	151	60·7
13	20	16·5	21,895	225	97·3
40	0	17·4	36,260	359	101·0
120	0	18·3	57,130	494	115·6
360	0	19·2	61,595	551	111·8

It will be seen that, up to about magnitude 10, the number of stars in the Milky Way is about 2·5 times that at the pole. After magnitude 13, the ratio increases with great rapidity, until at about the 17th magnitude the ratio is more than 100. If the stars were everywhere as dense as in this part of the Galaxy their number would be 2·5 billions, while if the density were that at the pole, their number would be 23 millions.

Research Items.

DEPOPULATION OF PRIMITIVE COMMUNITIES.—Mr. J. H. Hutton, whose monographs on two branches of the Naga Tribes in Assam have been received with much favour by ethnologists, reviews in *Man in India* (vol. 2, No. 4) the work of the late Dr. Rivers on depopulation in Melanesia, in the light of his experiences in Assam. He notes that, as in the case of the Kava of Melanesia, the influence of missionary societies in Assam, who discourage the use of the mild rice beer, is driving their converts to opium. The appearance of consumption in recent years in the Naga hills may be attributed to the wearing of European clothes, which is also responsible for the spread of dysentery, itch, and yaws. The absolute prohibition of head-hunting has led to serious interference with all sorts of dependent activities, and ultimately leads to a total lack of interest in life, and so to the limitation of families, or even to the total refusal to procreate children. These facts, which corroborate the conclusions of Mr. Henry Balfour in the presidential address recently delivered before the Folklore Society, deserve the serious attention of all those who are responsible for the welfare of primitive societies.

BRONZE AGE WEAPONS IN THE HULL MUSEUM.—In *The Naturalist*, No. 795, for April, Mr. T. Sheppard reports further valuable additions to the collections in the Hull Museum. Some of these pieces formed part of the Scarborough hoard, of which twenty-three are now in the museum. The new examples include some interesting axes and palstaves. An analysis of one of the axes by Prof. Cecil H. Desch shows that it contains 80·25 per cent. of copper, 16·39 per cent. of tin, and minute quantities of lead, nickel, and sulphur.

CONTRACTION AND DILATATION OF BLOOD-VESSEL.—Special interest has been aroused by the work of the Petrograd physiologist Kravkoff, who is already known for his work on the contraction and dilatation of the blood-vessels of surviving organs. Kravkoff usually employs rabbits' ears, which retain their vitality for a long time. Even after keeping these organs for several days and weeks he obtained a definite reaction with adrenalin. In his investigation he devised two methods for preserving the ears. As the ears usually perish from infection contracted at the cut surface, he seals that end by dipping the excised ears into a vessel with molten paraffin. When the paraffin solidifies the ears stand up in the vessel like plants in a flower-pot, and in this way the vital properties of the vessels are preserved for a long time. The second method is that of drying. The ears are dried in an evacuated desiccator over sulphuric acid until the moisture content is 5-6 per cent. Such preparations can be kept for about three months, and after soaking they respond to chemical stimuli. In this way also organs of higher animals show parabiosis after drying. It was also found convenient to employ human fingers, from amputations or later from corpses, for the study of the blood-vessels. These organs are just as sensitive in responding to poisons and adrenalin and can be utilised as anatomical specimens as well. They can also be preserved and dried. These surviving organs also possess the property characteristic of living animals, that their skin reacts to cantharadine, producing a focus of local inflammation with a blood-vessel reaction and tissue œdema.

THE ALLANTOIC PLACENTA OF MARSUPIALS.—One of the results of the visit of the British Association for the Advancement of Science to Australia in 1914 was the establishment of a committee to promote the collection of material for the study of the marsupials, with special reference to their embryology, a task rendered imperative by the rapid extermination of the native fauna. The principal part of the work of this committee was entrusted to Prof. T. Thomson Flynn of the University of Tasmania, who gives us the first instalment of his embryological results in a memoir on the Yolk-Sac and Allantoic Placenta in Perameles, published in the current number of the *Quarterly Journal of Microscopical Science* (vol. 67, part 1). It was in Perameles that Prof. J. P. Hill first discovered the existence of an allantoic placenta in the supposedly "non-placental" marsupials. Prof. Flynn confirms and extends Hill's observations, and endeavours, apparently with success, to reconcile the supposed discrepancy between the development of the marsupial allanto-placenta and that of the primitive eutherian type, maintaining that the difference between the two is one of degree rather than of kind. He draws a close comparison between the early stage of the allanto-placenta in Perameles and that of the dog, and holds that both can be derived from a common ancestral condition. He agrees with Hill in attributing the absence of an allantoic placenta in the majority of the Marsupialia to degeneration.

THE PLEISTOCENE OF NORTH AMERICA AND ITS VERTEBRATES.—The Carnegie Institution of Washington has issued as its Publication No. 322 a substantial volume by Mr. O. P. Hay on "The Pleistocene of North America and its Vertebrated Animals from the States east of the Mississippi River and from the Canadian Provinces east of longitude 95°." By the author, who is obviously a thoroughgoing glacialist, "the Pleistocene is regarded as being equivalent to what is known as the Glacial Period," and is divided by him into nine stages, five glacial and four interglacial, while the Blanco is held to belong to the upper, or uppermost, Pliocene. His Pleistocene is, therefore, obviously not quite homologous with the period that passes under that name with British geologists. The various vertebrates are first dealt with mostly in groups, cetaceans, mastodons, etc., but sometimes by individuals, as in the case of three species of Elephas; and their occurrences in each State, county by county, is recorded and charted on maps. To this succeeds a section on the Pleistocene geology of the several States, with the assemblages of animals found in the various beds. Whether the value of all this painstaking work will prove commensurate with its bulk of 500 octavo pages, time alone can show. The author's conclusions as to the dates of advent and disappearance of the different forms that are summed up in the table on pp. 14-15 depend obviously on the correctness or otherwise of the determination of the age of the individual deposits in which their remains occur, a matter concerning which the author himself appears frequently to be doubtful, and on whether all the fossil contents of a given bed truly belong thereto, as the author seems always to assume, or may in some cases be mixed with others derived from older horizons. In any case this memoir will prove most useful to all interested in the subject, whether from the geological or palæontological point of view.

VIRUS DISEASES OF PLANTS.—The brief report in *Phytopathology*, vol. 13, No. 4, of the symposium upon mosaic diseases by the Physiological Section of the Botanical Society of America and the American Phytopathological Society records proceedings which

should be of outstanding interest to students of plant pathology and ultimately perhaps of very great importance to agriculture. As a result of the papers communicated at this meeting, it appears that several cases of leaf mosaic and even that important economic disease problem, the leaf roll of potato, may have to be removed from the category of virus diseases and assigned to the category of diseases of which the causal agents are protozoa. Ray Nelson is reported to have produced photomicrographs illustrating definite flagellate protozoa found constantly associated with leaf roll of potato and the mosaic of bean, clover, and tomato. In the light of this paper, the tendency seems to be to regard the intracellular bodies reported by L. O. Kunkel, and by H. H. McKinney, Sophia H. Eckerson, and R. W. Webb, in cases of mosaic disease, as also protozoal in nature. It will be remembered that Kenneth H. Smith briefly reported in NATURE of November 18, 1922, p. 668, the presence of curious intracellular bodies in the case of mosaic of potato, and demonstrated these at the meeting of the Association of Economic Biologists devoted to a discussion of virus diseases. A joint discussion upon this subject between the Sections of Botany and Agriculture is put down for the Liverpool meeting of the British Association, and it is much to be hoped that upon this occasion something may be heard of this new work upon the subject, as the report in *Phytopathology* concludes with the statement that "without doubt this symposium marks an important milestone in the progress of plant pathology."

JAPANESE UROMYCES.—Seïya Ito, professor of phytopathology, College of Agriculture, Hokkaido Imperial University, has contributed a monograph on the Uromyces of Japan, which forms Pt. 4, vol. xi., of the Journal of the College. He describes fifty-six species of Uromyces and three of Pileolaria, giving figures of the spores; 19 species are endemic, 23 common to Europe, and 23 to America. One new species is described, *Uromyces Viciæ-unijugæ* Ito. Eight of these species had not previously been recorded from Japan. Japanese rust fungi will in future be known to us mainly through the investigations of Japanese mycologists, and yet it was only in 1858 that M. J. Berkeley and M. A. Curtis described the first two rust fungi recorded from Japan.

SIZE AND FORM IN THE VASCULAR TRACTS OF PRIMITIVE PLANTS.—Continuing his studies of the influence of size upon form, Prof. F. O. Bower, in the Proceedings of the Royal Society of Edinburgh, vol. 43, Part 1, concludes, mainly as the result of a reconsideration of the figures of the axial stele and petiolar trace in the fossil Cœnopterideæ, that increase in size is followed by decentralisation of the vascular tracts. Various factors, such as mechanical necessities, requirements of tissue ventilation, and so on, may co-operate in bringing about this result, but the author concludes that "there is certainly some other factor which it is more difficult to define than it is to point out its consequences." In the light of the considerations now advanced Prof. Bower is prepared to see a "writing down" of the value of primary vascular characters for the purposes of comparison and phylesis, as such characters may result from homoplastic change consequent upon change in size. The same consideration raises the query whether simplicity of structure is to be associated with small dimensions, so that fossils of small size, like the Rhynie plants, may be anticipated to be primitive.

ABNORMAL WEATHER IN THE BRITISH ISLES.—Exceptional weather conditions in England, either abnormally cold or warm, are of sufficient interest to warrant scientific inquiry, especially with the view ultimately of forecasting such extreme weather changes. The *Meteorological Magazine* for June contains an article by Mr. C. E. P. Brooks of the Meteorological Office on "Sea Temperature, Pressure Distribution, and Weather of May 1923." It is clearly shown that the abnormally cold and showery weather of May was due to persistent north-westerly winds associated with a steep pressure gradient between an anticyclone over the North Atlantic and a depression over the south of Norway. The author attributes the abnormal conditions to the consequences of the abnormal summer of 1921. That summer, which will be remembered as abnormally fine and dry over England, was marked by open stormy conditions in the Arctic Ocean, which set free large quantities of polar ice. This reached Iceland in the spring of 1922, and lowered the temperature of the surrounding ocean; in consequence the pressure rose and the tracks of depressions were driven southward, causing the unfavourable British summer of 1922. Towards the close of 1922 the bulk of the ice passed into the Labrador current, and this helped to lower the temperature of the Gulf Stream. The combined conditions caused an abnormally cold spring this year in the United States. The mean sea temperature immediately to the westward of the British Isles was about 2°·5 F. below the normal, and this low temperature is said to have been partially the cause of the high pressure over the central Atlantic during May. It is to be hoped that the abnormally hot weather of July, with its associated thunderstorms, will be subjected to a similar searching inquiry.

OIL AND GAS RESOURCES, OSAGE, OKLAHOMA.—In Bulletin 686 of the United States Geological Survey is incorporated in one volume the several advance chapters issued between 1918 and 1920 dealing with this important oil-bearing territory in Oklahoma. Apart from the excellent structure-maps included with the geological text, Mr. David White, chief geologist, contributes a significant introduction. The work done on this Osage Reservation is a direct response to what Mr. White rightly terms "the imperative need for increasing to the utmost the petroleum supply of the United States." The area demanded special attention in this connexion for six reasons: it contains a great acreage of unleased oil-lands, the productivity of certain developed areas is already high, the structures are favourable, the oil is of high quality, transport and refinery facilities are already at hand, and the Office of Indian Affairs (which administers lands held in common by the Osage Indians) has been offering leases to competitive bidders. Unfortunately many of these leases, including some already taken up, are, geologically speaking, unfavourable, while others which have been neglected have great possibilities. In these circumstances organised geological survey was essential, and by means of a system whereby reports were published as soon as delivered by the geologists, prospectors and others interested were able to get first-hand information to guide them in their choice of land. The lucid description of structural principles and geological terms employed, together with the explanatory remarks in the introduction, renders this bulletin much less formal in character than is usually the case with technical productions, though a short comprehensive summary of the principal geological and economic features of the whole region might have been included with advantage for the benefit of those unconversant with local detail.

The Liverpool Meeting of the British Association.

I.—LOCAL ARRANGEMENTS.

THE preliminary programme and invitation circular for the meeting at Liverpool of the British Association in September has recently been issued, and the subjects of the various presidential addresses and the chief sectional discussions have been mentioned in NATURE for June 16, p. 825. A short account of the local arrangements may, however, be of interest to members of the Association who intend coming to Liverpool, as well as to others who are as yet undecided about their attendance at the meeting.

The Reception Room and the General Offices will be at St. George's Hall, though accommodation will also be provided at the University for meeting rooms, etc., for offices and members if required. St. George's Hall, though rather more than half a mile from the University, where very many of the sections will hold their meetings, is admirably situated in the centre of the city, close to the railway stations and easily accessible by tram from all parts. The experience of the last meeting showed how excellent a reception room it proved, while its beautiful tessellated floor adds a decorative value most reception rooms lack.

Section E (Geography), and Section F (Economics) will meet in St. George's Hall, the former in the concert room and the latter in one of the large rooms used ordinarily for purposes of the assizes. These rooms being in the same building as the Reception Room itself could not be more convenient. Section H (Anthropology) will meet in the lecture theatre belonging to the Public Museum, not more than a few minutes' walk from the Reception Room. The other sections will all meet in the University buildings. For convenience of getting to and fro between the Reception Room and the University, it is proposed to run a service of motor buses.

The inaugural meeting and presidential address, as well as the evening lecture by Prof. Elliot Smith, will be held in the Philharmonic Hall, which has a seating capacity of about 3000. Citizens' lectures will be given in the Picton Hall, Liverpool, as well as in several of the neighbouring boroughs, and it is also intended to give a few lectures to young people, as these proved such a great success at last year's meeting at Hull.

The Lord Mayor is giving a reception to members of the Association in the Walker Art Gallery and Museum and Library (all three buildings being "en suite") on Thursday evening, September 13, and for that occasion it has been arranged to exhibit the greater portion of the permanent art collections of the city as well as to show exhibits of interest in the Library and Museum.

On the last evening of the meeting, Tuesday September 18, a scientific soirée will be held at the University. This gathering, based on the lines of the Royal Society functions, will, it is believed, be of the greatest interest, as a very large number of exhibits and experiments illustrating recent developments in science will be on view. There will also be a series of lecturettes by eminent men of science. It may be mentioned that the committee engaged in the organisation of this soirée at the University hope that as many members of the Association as possible will wear full academic dress on that occasion.

During the whole of the meeting, an exhibition of scientific apparatus, specimens, diagrams, etc., representative of the work of all the thirteen sections of the Association, will be on view in the Central Technical School, kindly placed at the disposal of the local committee by the Technical and Commercial Education Sub-Committee of the Corporation. This exhibition should prove of interest to all members, if one may judge from the small sectional exhibits which have been features of the Association meetings on several occasions during the last decade. All members of the Association will be admitted free.

A comprehensive series of excursions and visits to works and places of interest in the neighbourhood is being arranged, and the local committee hope the programme will provide interest for all.

A special handbook is in preparation. It will contain a number of articles dealing with the whole district of which Liverpool is the centre, rather than being restricted to the city and its immediate environs. It is hoped members will find it of more than merely ephemeral interest, as the articles are all by authors well qualified to write on their particular subjects.

Every effort is being made by the local committee to make the meeting a signal success. It is hoped very much that all those interested in science, even if not actually professional scientific workers, will attend. The local programme is developing week by week, and there is no doubt that by the date the meeting commences, provision will have been made for every minute of the member's day. ALFRED HOLT.

The Thunderstorm of July 9–10 over Southern England.

THE thunderstorm which visited London during the night of July 9–10 will find a place on the list of famous storms rather for its duration and for the spectacular effect produced at night by the incessant lightning, than for the quantity of rain associated with it or the damage done, though neither of these was by any means negligible. It is too early yet to attempt anything like a complete account of the storm, but data already at hand, and personal observations generously placed at my disposal, render a preliminary note possible.

Apart from the long duration, the most noteworthy general characteristics appear to have been the sudden development with little in the way of sky signs to aid the isolated observer, the general lack of hail, the absence of any marked squalls of wind at the surface, and the very marked preponderance of cloud-to-cloud discharges, without which the damage might have been very much worse.

The storm[1] first made its appearance about 8.30 P.M. (Greenwich time) on the south coast, where it was seen approaching from the south-east. It then progressed N.N.W., in the direction of London, where a corresponding phase was reached about two hours later, the system having advanced at a speed of roughly 25 miles per hour. This rate of movement appears to have been maintained in the same direction across Bedford and Peterborough, and then, rather faster, on to Hull and Middlesbrough. Thunderstorms which occurred later on July 10 at Berwick,

[1] The disturbance as a whole is referred to as the storm, but the system undoubtedly had several nuclei.

Aberdeen and in the Shetlands, all on the continuation of this line, were not improbably related to the same general cause, though the continuity of the advance of the original system cannot be verified.

The main rainfall was confined to a belt between 30 and 40 miles in width, lying along the track of the storm. In this zone, falls were probably everywhere greater than 1 in., at least as far north as the Wash, while they equalled 2 in. in many places, and reached 3 in. in isolated patches. On the south coast this belt of heavy rain extended from a point between Worthing and Brighton to a point between Eastbourne and Hastings, while central London lay in the middle of the affected zone. Outside this band, amounts fell off quickly, particularly on the eastern side, where the boundary was sharply defined; for example, while Eastbourne received 1¾ in., Hastings and places further east escaped rain, and while Tunbridge Wells experienced nearly an inch, there was none at Maidstone.

Over the southern portion of the track, including London, rain fell practically continuously for more than 6 hours, so that, allowing the speed of 25 miles per hour, the main travelling rain system responsible for this belt of precipitation was here probably about 150 miles long in the direction of its motion, and 35 miles broad.

In the north, the amounts and duration of rainfall appear to have been rather less than in the south of England.

Striking agreement in time is shown by the hyetograph and microbarograph records at South Kensington between sudden changes of pressure and intense bursts of rain, particularly just after 2 A.M. (G.M.T.). There is also agreement between the sudden changes of pressure at South Kensington and those recorded at Kingsway, London, W.C.2, by the Dines float barograph, which shows the absolute magnitude of the pressure changes. It is interesting to mention that an observer in Hampstead noted quite independently that the worst crashes, followed immediately by torrential rain, occurred at 2.15 A.M. and 3.45 A.M. (G.M.T.). The first of these was about 10 minutes after the occurrence of the very pronounced peak in the Kensington microbarograph record and corresponding heavy rain shown by the hyetograph record. Thus, allowing 4 miles between the places of observation, we again find phenomena associated with the storm travelling at about 25 miles per hour.

Although a closer investigation is desirable before putting forward an explanation of the storm with full confidence, an examination of the weather charts and upper air data available brings to light some very suggestive facts. Measurements of upper winds on the evening before the storm show that between about 6000 feet and 18,000 feet above the surface there was a general wind current over the affected area agreeing very closely indeed in direction and speed with those of the movement of disturbance itself, and observations of the drift of cirrus cloud show that above this the air motion was probably from about S.W. Now the weather charts for July 8 and 9 show an anticyclone over the Continent and a depression almost stationary off the West of Ireland, and, further, a current of air of undoubtedly polar origin, and therefore probably having a low upper-air temperature, circulating round the latter.

It seems very likely that some of this polar air, in arriving, at some upper level, over the south-west districts of England and endeavouring to work its way northwards, side by side with the very warm air of continental origin over the eastern districts, spread laterally over the latter, producing the travelling area of instability necessary to explain the phenomena described above.

M. A. GIBLETT.

The Pascal Commemoration on the Puy de Dôme.

THE tercentenary of the birth of Blaise Pascal (born June 19, 1623, died August 19, 1662) was celebrated at Clermont-Ferrand in a series of fêtes at which the President of the French Republic, M. Millerand, and the most distinguished French scholars and philosophers met to do homage to his great genius.

The culminating interest of the celebrations was the visit to the summit of the Puy de Dôme on Sunday, July 8, to commemorate the experiment devised by Pascal and carried out successfully by his brother-in-law Florin Périer, an experiment as famous in its day and as decisive in its significance as the eclipse expedition of May 1919 has proved to be in our day. In demonstrating that the atmosphere has weight it destroyed a principle of the old physics which had become authoritative, the principle that Nature abhors a vacuum, and at the same time it inaugurated a new scientific concept in physics. The rain poured as we gathered on the summit where, above the ruins of an ancient temple of Mercury, a modern meteorological observatory has been erected. Those who were so fortunate as to find room in the small cupola of the observatory, however, are not likely to forget M. Painlevé's discourse. Round the President were grouped the Prefects of the Departments, the Mayor of Clermont, the Rector of the University, Senators and Deputies, the representatives of the Institut de France, and the foreign guests of the Municipality. In an eloquent oration M. Painlevé described the inception of the great experiment and discussed its significance.

No one of that large company (the Municipality entertained three hundred guests at the *déjeuner* on the mountain) who had ascended the mountain by the modern means of electric traction with luxurious comfort in little more than an hour can have failed to reflect on the different conditions which prevailed in Pascal's time, and on the enormous difficulties of the original expedition. Those who are interested may read the full and careful report of it in Périer's letter to Pascal. It was arranged that first of all two sets of apparatus should be tested side by side to see that they gave identical measurements, that is, to see that each column of mercury in the inverted tubes (barometer tubes) remained at the same height. One set was then carried up to the top of the mountain and the other left behind in the church of the Minimes at Clermont. The experiments with each set were made at the prearranged hour and precisely recorded. The significance of the experiment was its uniqueness. It differed entirely from observations which any one might make with the scientific intention of recording facts; it differed entirely, for example, from observations such as those of Tycho Brahe. It was uniquely designed to test a physical theory which would stand or fall by the result. It had been known practically by engineers for a long time that there was a natural limit to the action of a pump, and in the crucial experiment of Torricelli with the column of mercury in the glass tube closed at one end and immersed in liquid at the other it was shown that the principle was

the same as that which was applied to the action of pumps, with the difference presumably due to the density of the liquid.

The problem was not the fact but its significance. The Aristotelians held that it had been definitely established that the atmosphere had no weight, and what is quite certain is that no means of discovering its weight, if it had any, then existed. It is therefore strikingly analogous to the case of the hypothetical ether when physicists were engaged in devising means of revealing its presence. Descartes, though entirely opposed to the Aristotelians, yet held on *a priori* grounds that the universe was a plenum. He needed the concept in order to explain the vortex motion which in his view accounted for the variety of material forms. The apparent vacuum in the Torricelli tube he supposed to be due not to an absence but to the presence, or rather to the entrance under the conditions of the experiment, of a very subtle matter. Pascal, on the other hand, to quote M. Painlevé, " s'inspirant de Galilée et Torricelli, entre la science d'Archimède et la science moderne, jette un pont par-dessus vingt siècles. La presse hydraulique, le baromètre observé à diverses altitudes, ce sont les illustrations d'une statique nouvelle qui embrasse à la fois, dans les mêmes principes, l'équilibre des liquides et celui des gaz." Let us imagine, he went on to say, that through some disaster everything which we now know about Pascal had been lost to us save only his scientific writings. In what light would he appear to us? We should be right to point him out as the first of the positivists methodically disengaging facts from the confusion of words, discrediting purely verbal definitions, " cet air subtil qui aurait des inclinations," " cette lumière qui est un mouvement luminaire de corpuscules lumineux."

Other memorable discourses followed, in particular one by M. Picard, before we sat down to the sumptuous banquet which the Municipality offered its guests. When this was concluded the President of the Republic rose and to the enthusiastic applause of the company, though, it must be admitted, to the general surprise of those who were thinking of Pascal, delivered an impassioned and truly eloquent speech on the politics of the hour, which was immediately transmitted round the world. The rain ceased, and we made the return journey to Clermont favoured by a clear sky and splendid view over the grand Auvergne country. The city was gaily decorated for another celebration in the square over which the statue of the seated Pascal presides. H. WILDON CARR.

An Advance in Photometry.

HERR E. STEINKE, in an investigation into the accuracy of the Wien-Planck law in the ultra-violet region of the spectrum, has recently made use of Elster and Geitel's potassium photo-electric cell, as neither the thermopile nor the bolometer was sufficiently sensitive to measure the minute quantities of radiant energy involved (*Zeits. f. Physik.*, 11. 4 and 5, pp. 215-238, 1922).

Herr Steinke has found it possible to increase the sensitiveness of the cell enormously, by increasing the voltage between the potassium anode and the platinum cathode; and has carefully investigated the behaviour of the cell under these conditions. For red light, $\lambda = 630\mu\mu$, an increase in voltage from 20 to 210 multiplies the sensitiveness by 1045 and for violet light, $\lambda = 462\mu\mu$, by 1595. This is due to the increased ionisation from collisions between the greatly accelerated electrons and the argon contained in the cell.

It was not possible to apply such a high voltage to the cell suddenly without a luminous discharge; it was necessary to raise it gradually for hours or even days at a time, and it was then possible to reach the 210 volts already mentioned. At 212 volts luminous discharge took place, after which the cell discharged at 162 volts, recovering if left to itself for some days, so that the potential could again be raised to 200 volts. In forming the cell, as above, for high voltages it was found that each time the voltage was increased there was a strong " darkness " current at first; which diminished in the course of time to zero for lower voltages, and at 210 volts to a moderate value after several days.

When the cell is prepared in this way, and is illuminated, a fatigue effect is observed, the time required for the thread of the Lutz-Edelmann electrometer to move from a certain division on the scale to another (85 to 65) gradually increasing to a limiting value, which in one experiment was reached in about fifteen minutes. This limiting value was determined in all the experiments. These were always made in the order of increasing illumination, as it was found that a high illumination produced a kind of after action, and a small illumination measured shortly afterwards showed a higher value than the real one. For the high voltages employed the limiting value of the photo-electric current was not proportional to the illumination, as it was found to be by Elster and Geitel for moderate voltages; but the following relation was proved to exist, $I^z = ML$; where I is the photo-electric current, L the flow of radiant energy, and z and M are constants. The cell constant z varies with the wave-length, and with the voltage applied to the cell; for small voltages it scarcely differs from unity, and the law becomes identical with that of Elster and Geitel; for $\lambda = 316\mu\mu$ z was observed to be 1·3495, with 208 volts on the cell terminals, and intermediate values were found for other wave-lengths and voltages.

Using the method described, Herr Steinke has measured the exponent c_2 in Planck's formula $E\lambda = \frac{C}{\lambda^5}\frac{1}{e^{c_2/\lambda T} - 1}$ for a number of different wave-lengths, including $340\mu\mu$ and $316\mu\mu$ in the ultra violet. The mean value is 14,385, the largest variation from this being 0·63 per cent., and the mean probable error 0·16 per cent. The actual probable error is rather greater than this, owing to the difficulty of determining the wave-length of the rays employed, which were separated from the light of a carbon incandescent lamp by filters. The value agrees satisfactorily with that determined by previous observers for visible radiations. The observations also show that carbon radiates, throughout the range of wave-lengths investigated, as a grey body. Herr Steinke proposes to continue the investigation, and to measure the constant C in the above formula.

It would appear that the improved method of using the photo-electric cell should prove of the highest value in work on the spectrum, particularly in the ultra violet.

International Conference on Nature Reserves.

THREE Associations in France entitled, respectively, the Société Nationale d'Acclimatation de France, the Ligue Français pour la Protection des Animaux, and the Société pour la Protection des Paysages de France, recently invited the Royal Society for the Promotion of Nature Reserves to send delegates to attend a conference " Pour la Protection de la

Nature." This Conference was held in Paris on May 31-June 2 last, and at the request of the Society for the Promotion of Nature Reserves it was attended by Lord Ullswater, Mr. E. G. B. Meade Waldo, and Mr. Percy R. Lowe (British Museum, Natural History).

The Conference was presided over by M. Mangin, director of the National Museum of Natural History in Paris, and was divided into five sections: (i.) fauna, (ii.) flora, (iii.) geological, (iv.) sites and landscapes, (v.) general.

At the sittings of the various sections papers were read in French by many members upon a great variety of topics. Most of the speakers dealt with the subject matter of the Conference so far as it affected their own country or their own special part of it, and few treated the subject from a general point of view. The paper read by the Swiss delegate was a striking exception to this rule, while M. Burdet's lecture, illustrated with slides, which dealt with the Nature reserves of Holland, was a very useful and practical contribution to the Conference.

It was felt by the representatives of the Royal Society for the Promotion of Nature Reserves that in any similar future conference a series of resolutions, not too many in number, should be prepared and circulated some weeks before the Conference, so that there might be ample opportunity for their discussion, emendation, adoption, or rejection. Such resolutions should deal with the subject matter from a general point of view, and should indicate the best method of establishing Nature reserves, whether by State legislation or private enterprise; in what manner such reserves might be best administered; how funds might be obtained for the purpose; how the rights of individuals in the lands in question are to be protected, modified, or abolished; how the selection of the proposed public parks or nature reserves is to be determined; and in what manner subordinate questions arising therefrom are to be answered.

University and Educational Intelligence.

GLASGOW.—Prof. Andrew Gray has intimated his desire to retire from the chair of natural philosophy on September 30 next, on grounds of health. Prof. Gray has occupied the chair since 1899, when he succeeded Lord Kelvin. During his tenure of office the fine institute of Natural Philosophy, which was designed and erected under his direction, has been added to the numerous new scientific buildings of the University. Some 1100 students a year are accommodated in its spacious laboratories and classrooms.

CAMBRIDGE.—In connexion with the recent international conference of chemists in Cambridge honorary doctorates in science were conferred upon a number of distinguished foreign chemists. In introducing them to the University the Public Orator spoke as follows:

Multa nobis antiquitas tradidit quibus adhuc nititur humana vita; multa recentiores reppererunt et quotidie nova profert usus. Quantas omnium mutationes induxerit vapor domitus et quasi freno subditus, quantas explorata res chemica, nulli non est notum. Inter se ergo consociati sunt illi qui, sive ipso veritatis amore, sive commercii causa promovendi chemica tractant, et quotannis concilium convocant. Hoc anno patriam nostram petierunt et inter urbes Britannicas Cantabrigiam. Multarum gentium legatos praesentes videre laetamur; abesse adhuc dolemus nonnullarum. Universitas nostra voluit e tanta frequentia quosdam titulo doctoris decorare, quo patefactum sit omnibus quanto honore et haec studia et qui eis se dederint universos habeamus.

Primum vobis praesento ALBINUM HALLER. Quidquid enim in scientiis apud Francos agitur, in Academiam suam Scientiarum conferunt; hoc in circulo conveniunt omnes qui haec studia prosequuntur; huic quasi senatui curiaeque quotannis praeficitur vir egregius. Quem ergo fraternitas sua honore tali dignata sit, illum et nos honorare volumus.

Sequitur WILDER DWIGHT BANCROFT et studiis et affinitate nobis conjunctus, qui alter Ulixes multorum providus, novam Ithacam novis artibus illuminavit.

Itidem provenit ERNESTUS JULIUS COHEN, quem in Academia sua Rheno-Trajectina, ut Ovidium alterum

> in nova fert animus mutatas dicere formas
> corpora.

Francus et alius insequitur, apud Parisios in Collegio Francorum professor, CAROLUS MOUREU, non ille rerum contemptor minutissimarum sed inquisitor acerrimus.

Hodie, dum procul horrificis tonat Aetna ruinis, non usitato salutamus Italum, RAFAELEM NASINI, quem nobis misit urbs Etrusca, Vergilio nota, Alphaeae ab origine Pisae. Hic explorandos sibi Volcani delegit vapores,

> qualis sese halitus atris
> faucibus effundens supera ad convexa volarit,

necnon et Albunea qualem

> exhalet opaca mephitim.

Helvetius quoque adest, iam senior, Universitatis Genevensis professor, AMATUS PICTET, qui bases rerum inspexit, ad investigandum curiosus quae vacuum per inane fieri possint.

Gandavensis item Academiae professor advenit, cuius si velitis opera recognoscere sunt qui possint oratione fluentiore vobis exponere; constat tamen illorum qui talia tractant nullum FREDERICO SWARTS antecellere.

> Felix qui potuit rerum cognoscere causas!

Credo equidem, sed non omnibus omnia concessere Parcae. Arcadiam nactus sum, Musarum antiquiorum aedituus indignus, contempto in fano ministrare laetus. Vos quorum est prodigia tractare e terra Cham exorta, quaeso mihi ignoscite, si linguarum nescius singularum Latine vos gaudere iubeam universos.

LIVERPOOL.—Following on the death of his widow, the estate of the late Prof. Campbell Brown has been handed over to the university under the conditions stated in his will. These provide that: (1) A Campbell Brown chair of industrial chemistry shall be established with an endowment of 1200*l*., the first professor to specialise in oils, fats, and waxes. In the first instance the salary shall be 1000*l*. per annum. (2) The income of a sum of 5000*l*. shall be placed at the disposal of the professor for the upkeep of his department. (3) A Campbell Brown fellowship, value 150*l*. per annum, for senior and honours chemistry students, not necessarily trained in Liverpool, shall be established; and (4) The balance of the bequest shall be invested and accumulated until sufficient income accrues to enable entrance scholarships of the value of 80*l*. per annum, tenable for three or four years, to be offered.

LONDON.—The following doctorates have been awarded: *Ph.D.* (*Science*): Mr. L. Hall (Battersea Polytechnic) for a thesis entitled "The Study of

Optical Activity"; Mr. H. Phillips (Battersea Polytechnic) for a thesis entitled "The Relation between Chemical Constitution and Optical Rotatory Power"; Mr. A. Brammall (Imperial College, Royal College of Science) for a thesis entitled "The Mineralogy, Structure, and Petrology of the Dartmoor Granite"; Mr. H. Schofield (Imperial College, Royal College of Science) for a thesis entitled "The Measurement of Thermal and Combustion Efficiency of High Speed Multi-Cylinder Internal Combustion Engines by the use of a new Optical Indicator," and Mr. R. L. Smith-Rose (Imperial College, Royal College of Science and City and Guilds College) for a thesis entitled "On the Variations of the Apparent Bearings of Fixed Radio-Transmitting Stations." *Ph.D.* (*Engineering*): Mr. H. F. G. Letson (East London College) for a thesis entitled "The Experimental Determination of the Temperature Distribution, and Calculation of the Thermal Stresses in a Diesel Engine Cylinder Liner."

Applications are invited for the William Julius Mickle fellowship, of the value of at least 200*l.*, awarded annually to the man or woman resident in London and a graduate of the university who is deemed by the Senate to have done most to advance medical art or science within the five preceding years. Applications must reach the Principal Officer of the University, South Kensington, S.W.7, by at latest, the first post of October 1 next.

ON July 27, the summer meeting of the University of Oxford Delegacy for the Extension of Teaching opens with an inaugural lecture by Sir Michael Sadler. We have already referred to the excellent programme which is being provided this year (NATURE, May 19, p. 688), which includes lectures on the functions of universities, the economics of English country life, and research in organic chemistry. Special railway facilities are being offered for those desirous of attending the meeting. Full particulars can be obtained from the Secretary, University Extension Delegacy, Examination Schools, Oxford.

THE jubilee celebrations of the Cambridge University Local Lectures began on Friday, July 6, with a special Congregation for the conferment of honorary degrees for distinguished service in the cause of university extension, namely, the degree of LL.D. on Sir Michael Sadler, Mr. R. G. Moulton of Christ's College, and Mr. Albert Mansbridge, and the degree of M.A. on Mr. G. P. Bailey, Mr. J. H. Fisher, and Mr. Alfred Cobham. On the Saturday and Monday there were meetings of a conference on extra-mural teaching. Speeches at the conference emphasised the far-reaching effects of the movement initiated in Cambridge by James Stuart in 1873, which has spread not only throughout the British Empire but to most of the civilised countries of the world, attaining its greatest and most various developments in the United States. The speeches dwelt also on the value to extra-mural lecturers of the stimulation they receive from lecturing to (and being cross-examined by) adult audiences, contrasting their eagerness with, and perhaps exaggerating, the lethargy and "anxiety to curb an exhibition of enthusiasm" of the normal undergraduate student. In the opinion of the Master of Balliol, those who are responsible for the further development of the movement are at a parting of the ways, and careful guidance will be needed if it is not to suffer the usual penalty of success and become absorbed in its own mechanism. Progress will depend largely on co-operation between universities, local authorities, and voluntary bodies.

Societies and Academies.

LONDON.

Mineralogical Society, June 19.—Dr. A. Hutchinson, president, in the chair.—L. J. **Spencer**, with chemical analyses by E. D. **Mountain**: New copper-lead minerals from the Mendip Hills (Somerset). Mendipite ($2PbO . PbCl_2$), which occurs as crystalline nodules in manganese-ore, is recorded from new localities. Chloroxiphite ($2PbO . Pb(OH)_2 . CuCl_2$) as green monoclinic blades resembling epidote, and diaboleite ($2Pb(OH)_2 . CuCl_2$) as bright-blue tetragonal plates resembling boleite, both occur embedded in the mendipite. Hydrocerussite ($2PbCO_3 . Pb(OH)_2$) is abundant, sometimes as large crystals (*i.e.* crystallised "white lead"). Crednerite ($CuO . Mn_2O_3$) forms fan-like aggregates of thin plates. Pyromorphite was, some centuries ago, evidently an important ore of lead in the Mendips. Wulfenite and mimetite have been found at Higher Pitts near Priddy. The various minerals show progressive stages of alteration with some well-marked pseudomorphs: mendipite ⟶ hydrocerussite ⟶ cerussite; chloroxiphite ⟶ hydrocerussite + malachite I ⟶ cerussite + crednerite ⟶ malachite II.—W. F. P. **McLintock**: On a petalite-bearing rock from Devonshire. The well-known aplite from Meldon in Devonshire develops in certain parts of the intrusion a soda-lithia phase rich in the rare lithium-aluminium silicate, petalite. This mineral, not previously known from Britain, occurs as one of the final products of consolidation of the aplite either in coarse-grained veins of pegmatite associated with quartz, orthoclase, albite, a lithia-bearing mica, tourmaline, and apatite, or as irregularly shaped masses throughout the rock itself. The petalite gives rise by decomposition to the pink clay, montmorillonite, so well known from this locality. Certain other veins, free from petalite, are also present, the most interesting constituents of the rarer types being prehnite, axinite, and a pleochroic cordierite. The apatite in the aplite is a pneumatolytic mineral occurring not only in the rock as ophitic patches enclosing quartz and felspar, but also impregnating certain xenoliths of peculiar type.—A. **Brammall** and H. F. **Harwood**: The accessory minerals of the Dartmoor granite. Tourmaline, which is one of the minerals identified, originated at two stages in the cooling history of the intrusion: (1) pre-solidification—primary and secondary; (2) post-solidification—secondary. The more severe and widespread pneumatolysis and the lodes are referred to a post-solidification stage.—Seitarō **Tsuboi**: (1) Optical dispersion of three intermediate plagioclases. The principal refractive indices, α, β, γ, of (*a*) oligoclase from Hawke mine, Bakersville, North Carolina, (*b*) andesine from Maeyama, Shinano, Japan, and (*c*) labradorite from County Down, Ireland, for light of 9 different wave-lengths, and the optical orientations of the first and the third of these felspars, for light of 5 different wave-lengths (700, 644, 589·3, 535, 508·5$\mu\mu$) were determined. (2) A dispersion method of determining plagioclases in cleavage-flakes. The method is based on the principle of H. E. Merwin's improved immersion method. By means of a diagram a quick and exact determination of plagioclases is possible. It is applicable to small crystals such as are common in rocks.—C. S. **Garnett**: The "toadstone-clays" of Derbyshire. The olivine-dolerites ("toadstones") of Derbyshire undergo two types of alteration: (1) by ordinary weathering to limonite or ochreous deposits; (2) in the absence of oxidising agents under a limestone covering, they may pass through dolerite-greenstone and "green-earth" to a greenish-white

or almost white clay ("toadstone-clay") with the composition $2Al_2O_3 . 6SiO_2 . 3H_2O$. — G. T. **Prior**: (1) The meteoric stone which was seen to fall at Ashdon, near Saffron Walden, Essex, on March 9, 1923. The stone, which weighed about 1300 grams, is a white chondrite showing on one face well-marked radiating lines of flow of the fused crust. (2) The Sinai meteorite. The meteoric stone of 1455 grams which was seen to fall near Kantara in the north of the Sinai Peninsula in July 1916 is an intermediate hypersthene-chondrite, having a percentage of nickel-iferous iron of about 8·6 in which the nickel amounts to about 15 per cent.—G. **Greenwood**: Communications from the Crystallographic Laboratory of the University of Manchester. No. 1. The detection of rotatory polarisation in an orthorhombic crystal exhibiting crossed axial dispersion. A plate perpendicular to the acute bisectrix of a crystal of triphenyl-bismuthine dichloride when in the extinction position transmits a brilliant green monochromatic light due to circular polarisation.—A. F. **Hallimond**: The chemical classification of the mica group. I. The acid micas.

Linnean Society, June 21.—Dr. A. B. Rendle, president, in the chair.—E. **Heron-Allen** and A. **Earland**: The Foraminifera of Lord Howe Island, South Pacific. Some 199 species of Foraminifera, identified from material collected by Prof. R. Douglas Laurie at Lord Howe Island in 1914, and including two new genera and seven new species, were described. The chief feature of the collection is the prevalence of forms in the condition of reproduction, (*a*) by viviparity, and (*b*) by budding.—T. A. **Dymes**: Seeds of the marsh orchids. The marsh orchids fall into two groups: (1) Maculatæ, and (2) Latifoliæ. The seeds of Maculatæ differ from those of the Latifoliæ in that the testal cells are sculptured. Seeds even from the same plant may vary greatly, though *Orchis majalis*, Reich. has uniform seeds. —A. **Dendy** and Miss Leslie M. **Frederick**: On a collection of sponges from the Abrolhos Islands, Western Australia. There are forty-eight determinable species, of which twelve are regarded as new. The Calcarea identified include a number of fine specimens of the rare *Grantiopsis cylindrica*, and there is a new species of the rare and remarkable "Pharetronid" genus Lelapia, and a new genus of Leucascidæ. The Tetraxonida form the bulk of the collection. The sponge fauna of the Abrolhos Islands is mainly intermediate in character between that of the more westerly Indian Ocean and that of the more easterly Australian coasts; but it contains a small element apparently derived from the north.—Ethel N. Miles **Thomas**: Observations on the seedling anatomy of the genus Ricinus. The presence of *alternate* or *root* xylem in the hypocotyl and cotyledons of several species of Ricinus, including *R. communis*, is established. At an early stage the alternate or radial elements *alone* are lignified. The tissue groupings associated with root structure are only found low in the axis, while above the collet eight stem bundles are found which are continued upwards as the four equally spaced bundles of the cotyledons. In addition, there are alternate xylem elements in the cotyledonary plane, *i.e.* that passing through the centre of each cotyledon. The existence, as well as the resorption, of these elements, which are usually in direct continuity with the cotyledonary root poles, has now been established in a large number of dicotyledonary species.—C. H. **O'Donoghue**: Opisthobranchiata collected in the Abrolhos Islands.

Royal Anthropological Institute, June 26.—Mr. H. J. E. Peake in the chair.—Hazzledine **Warren**: The palæolithic succession of Stoke Newington. The latest group which is found upon the Stoke Newington "floor" is a clearly-defined Mousterian industry, with fine examples of both *racloirs* and of the equally characteristic trimmed-flake points. Delicately finished pointed and ovate implements are also found. This "floor" occurs in the upper sandy beds of the terrace deposits, associated with a temperate flora, *Corbicula fluminalis*, and the northern migrating animals. The series of intermediate age are found in the underlying gravels of the terrace, and they constitute an equally well-defined late Chellean group. They are contemporary with the gravel. The third and apparently oldest series are greatly abraded derivatives, and they frequently exhibit a second series of abrasions and chips that are later than the patination of the flint. The dominant form of implement is a rude, thick, ovate type, made with a minimum of flaking, although occasionally better-finished examples are found. The pointed form occurs, but is less common. This series is comparable with the "Hill group" described by Prestwich from the Kentish plateau, and is considered by some to be of Early Acheulean date. There is, however, much cumulative evidence from other localities, besides Stoke Newington, which would appear to suggest that the derivative series of Stoke Newington may be older than the Chellean group as defined by Commont from the Somme Valley.

Aristotelian Society, July 2.—Prof. A. N. Whitehead, president, in the chair.—M. **Ginsberg**: The category of purpose in social science. The interpretation of purposive activity as consisting in the realisation of conscious factors involved in voluntary behaviour is misleading when applied to creative work and practical activity, and it breaks down in the biology of the lower organisms. The purposive must be related to the teleological. A comparison of mechanical, organic and purposive wholes shows the importance of viewing purposive wholes as a species subsumed under a wider genus, conational wholes. These may be defined as systems which maintain themselves as wholes by the striving of their parts towards mutual adjustment. They vary enormously in the degree of integration achieved, and the explicitness with which the ends of the system are realised by the parts of which they consist. Perhaps organisms are conational wholes. There are all sorts of organisms belonging to different levels of integration. So there are all sorts of social wholes, varying in plasticity, articulateness, and comprehensiveness. It is important to recognise integrations of different orders or levels, and the kind of integration achieved by societies is not the same as that which characterises the holding together of mental processes in one stream of consciousness. Institutions and tradition may be regarded as the result of trial-and-error experiments towards mutual adjustment.

DUBLIN.

Royal Dublin Society, June 26.—Prof. J. A. Scott in the chair.—H. G. **Becker**: Improved methods of evaporation under laboratory conditions. A special form of oil bath incorporating a wind-tunnel was used to determine the rate of evaporation of distilled water at different temperatures from 30° C. to 100° C., and in currents of air of different speeds, the rate of evaporation being measured by observing the fall of a glass float in the liquid. The rate is proportional to the vapour pressure up to 90° C.; above this temperature it increases more rapidly. By maintaining the water at 95° C. in a current of air of 500 ft.

per min. a sevenfold increase in the rate of evaporation was obtained as compared with the rate of evaporation on a water or steam bath. A new form of laboratory evaporator described consists of a glass bulb, containing the liquid, mounted on fibre bearings, and rotated by a small motor, while it is heated directly by a bunsen burner. The rotation prevents the liquid in contact with the glass bulb from becoming super-heated, and, besides keeping the liquid mixed, spreads it out in a thin film on the upper surface of the bulb while a current of air or indifferent gas can be blown through the bulb. It is possible to obtain rates of evaporation up to twenty-four times as great as that on the water bath.—H. G. **Becker** and W. E. **Abbott**: A rapid gasometric method of estimating dissolved oxygen and nitrogen in water. The gas is expelled by dissolving an electrolyte in the water, the displaced gas being liberated in a partial vacuum, collected, and measured. Caustic potash is the most satisfactory electrolyte. The analytical results are comparable with those obtained by the Winkler and boiling-out methods. The advantages claimed are simplicity of apparatus, rapidity, and smallness of the water sample required for a determination.—W. R. G. **Atkins** and M. V. **Lebour**: The hydrogen ion concentration of the soil and of natural waters in relation to the distribution of snails. The hydrogen ion concentration of the soil is a factor limiting the distribution of snails, which are far more numerous between $P_H 7$ and $P_H 8$ than elsewhere. Of 27 species of snails found in the districts studied, 4 species occurred at $P_H 5$, 20 species at $P_H 7$, and 14 species at $P_H 8$. Snails with hyaline shells occur over a wide range, but those with calcareous shells are limited to the more alkaline soils. Granite and quartzite regions have few species, basaltic districts have a more numerous fauna, and limestone areas are rich both in variety of species and number of individuals. The distribution of some species within the British Isles is probably explained by the "age and area" theory of Willis, rather than by a limitation through unfavourable ecological factors. *Cochlicella barbara* appears to have a western, and *Theba cantiana* an eastern, origin.

PARIS.

Academy of Sciences, June 25.—M. Albin Haller in the chair.—Maurice **Hamy**: The determination of small diameters by the interference method.—P. A. **Dangeard** and Pierre **Dangeard**: Second note on the vitality of leaves of Aucuba preserved in a vacuum. The Aucuba leaf after being in a vacuum for twelve months resembled, macroscopically and microscopically, a freshly plucked leaf. It retained its original green colour, and the vitality of its cells was undiminished.—Morin **Molliard**: The determining factor in the formation of conidia in *Sterigmatocystis nigra*. The formation of conidia is determined by a deficiency of phosphorus or other nutritive element in the culture fluid, together with an excess of potassium.—V. **Grignard** and R. **Escourrou**: The methylheptenols: their ketonic decomposition.—F. H. van den **Dungen**: Calculation of the simple poles of a meromorphic function.—Gino **Fano**: The congruence of the normals to a quadric.—L. **Décombe**: The analytical theory of irreversibility. Elementary isokinetic transformations.—C. **Gutton**, S. K. **Mitra**, and V. **Ylostalö**: The high-frequency discharge in rarefied gases. The frequency range in these experiments varied between 50 and 2,140,000, and tubes with internal and external electrodes were used, the gas being dry air. The potential varied with the frequency, and for tubes with internal electrodes the difference of potential always increased with the frequency; for tubes with external electrodes the pressure of the gas affected the relation between potential and frequency.—Jacques **Errera**: Colloidal supports for obtaining the emission spectra of solutions. The spark is passed between rods of gelatin containing the salt under examination; the method has the advantage that fewer lines are introduced into the spectra by the electrodes than when metal or glass supports are used for the solutions.—M. **Duffieux**: The mass of the particles which emit the secondary spectrum of hydrogen. The experiments described lead to the conclusion that all the lines examined in the secondary hydrogen spectrum must be attributed to the molecule of hydrogen.—Mlle. St. **Maracineanu**: Researches on the constant of polonium. Published values for the period of polonium vary between somewhat wide limits, 134·5 to 143 days. The value 139·5 days is regarded as the most probable. Deposition of radioactive substances on glass is preferable to deposition on metal plates in researches of this nature.—G. **Dupont** and L. **Desalbres**: A curious case of separation of optical isomerides by distillation and by crystallisation. A partial separation of active and inactive pinene can be made by fractional distillation with a very efficient column; evidence of a similar separation has been obtained by fractional crystallisation at $-75°$ C.—M. **Geloso**: Isotherms of the adsorption of salts by manganese dioxide. Experimental results of the adsorption of copper, nickel, and iron by precipitated manganese dioxide: a simple expression is deduced which accurately expresses the experimental data.—Paul **Pascal**: The magnetic properties of cyanic and cyanuric compounds. From a study of the magnetic susceptibility of compounds containing the groups (CNO) and $(C_3N_3O_3)$ and assuming the law of additivity, conclusions are drawn concerning the constitution of these compounds. Cyanuric acid is regarded as possessing a structure similar to the benzene nucleus, but isocyanurates and cyamelide differ in structure, although containing a six-atom ring.—André **Charriou**: The reciprocal displacement of substances carried down by precipitates. Chromic acid is carried down by a precipitate of aluminium hydroxide, and this cannot be washed out with water or with solutions of salts of monobasic acids; the chromic acid, however, can be removed completely by washing with solutions of salts of dibasic or tribasic acids (sulphate, oxalate, phosphate).—Henry E. **Armstrong**: The origin of osmotic effects. Hydronodynamic transformations in aqueous solutions. Discarding the Arrhenius theory as irrational and in disagreement with the facts, a résumé of the hydrone theory is given, and this is regarded as explaining all the properties of aqueous solutions.—Alfred **Gillet** and Fernand **Giot**: It is common knowledge that treatment of the fibre before dyeing with copper salts in some cases increases the fastness to light. It is shown experimentally that a preliminary treatment of the fibre with cuprous salts exerts a strong protective action against light for the dye 2B diamine blue.—Max and Michel **Polonovski**: The constitution of eserine.—Raymond **Delaby**: The action of formic acid on ethylglycerol. Conversion into β-ethylacrolein. The decomposition of the crude mixture of formins from ethylglycerol gives two unsaturated alcohols, vinylethylcarbinol, $CH_2 : CH . CH(OH) . C_2H_5$, and β-ethylallyl alcohol, $C_2H_5 . CH : CH . CH_2(OH)$, the latter being new.—M. **Pariselle**: A new working method for the preparation of camphene. In the ordinary method of preparing pinene hydrochloride a yield of 55-65 per cent. is obtained: the yield can be raised to 75 per cent. by conducting the saturation with hydrochloric acid in two steps, with a two days'

interval. For the conversion of the chlorhydrate into camphene, the substitution of the sodium derivative of cresol for sodium phenate gives a purer product in nearly quantitative yield.—L. **Barrabé**: The continuity of the drift series of the eastern Corbières between la Berre and Narbonne.—F. **Delhaye** and A. **Salée**: The Central African *Graben* between Lake Tanganyika and Lake Albert Edward.—Adolphe **Lepape**: The relations between the radioactivity, temperature, and hydrogen sulphide of the springs of Bagnères-de-Luchon. Explanatory hypothesis.—MM. Allyre **Chassevant** and **Chouchak**: The measurement of the degree of ionisation of mineral waters.—de Montessus **de Ballore**: The local prediction of the weather.—V. **Lubimenko** and Mlle. O. **Szegloff**: The adaptation of plants to the duration of the bright period of the day. Green plants show a specific adaptation to the period during which they are illuminated.—Louis **Desliens**: Venous hæmodynamometry. Cardiac hæmodynamometry.—J. **Beyne**: The origin of the accidents caused by strong atmospheric depressions, and on the protection of the aviator against troubles of anoxhæmic order. For moderate reductions of pressure it is sufficient to supply so much oxygen that its partial pressure should be nearly 21 per cent. of an atmosphere. At low pressures, corresponding to high altitudes (more than 10,000 metres), even when the wants of the organism as regards oxygen are met, there are still troubles which must be ascribed to other factors.—Jules **Amar**: The organisation of work with the spade.—L. J. **Simon** and E. **Aubel**: Is pyruvic acid one of the terms of decomposition of glucose in the course of glycolysis? Pyruvic acid is not transformed by the elements of the blood. It is not produced during the process of glycolysis, and cannot be considered as an intermediary product of the decomposition of glucose into lactic acid.—Ch. **Bedel**: The toxic power of a polymer of hydrocyanic acid. The experiments were made on the polymer possessing the composition $(HCN)_4$. This was found to be much less toxic than hydrocyanic acid.—Albert **Berthelot**: Researches on pyruvic acid considered as a factor in anaerobiosis.—Maurice **Wolf**: The importance of calcium and potassium in the pathological physiology of cancer.—Charles **Pérez**: The castration of decapod Crustacea carrying Epicaridæ as parasites.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 9, No. 5, May).—H. S. **Jennings**: (1) Crossing over and the theory that the genes are arranged in the chromosomes in serial order. Assuming that the genes are arranged linearly and that the occurrence of a break interferes in some way with the occurrence of another break at any joint within a certain distance, the cross-over ratios can be calculated. The theory is in accord with Morgan's work on Drosophila. (2) Some consequences of different extents of interference, in the crossing-over of the genes. For interference extending to a distance of 30 units (one unit being the distance between genes to give 1 per cent. of the crossing-over), no cross-over ratios greater than 50 per cent. are produced. With greater distances of interference, the cross-over ratios oscillate about 50.—J. A. **Detlefsen** and L. S. **Clemente**: Genetic variation in linkage values. In *Drosophila melanogaster*, the crossing-over ratio can be varied, but not necessarily to the same extent with regard to each part of the chromosome.—C. **Barus**: The displacements of the capillary electrometer, for progressive dilutions of the electrolyte. The negative meniscus is always displaced more rapidly than the positive meniscus, though the whole cycle is retarded by increasing dilution.—W. **Duane**: The transfer in quanta of radiation momentum to matter. It is assumed that the laws of the conservation of energy and momentum apply to these transfers. From a consideration of the reflection of X-rays by a crystal, equations expressing the momenta transferred to a crystal are developed. Applying dimensional reasoning, other expressions can be obtained which lead to the Braggs law of crystal reflection and the general equations of defraction of X-rays by a crystal. The reflection of X-rays characteristic of the chemical constituents of the crystal can be explained. The theory is also applied to the phenomena of light and radiation generally.—I. **Roman**: Mutual electromagnetic momentum and energy of a system of moving charges.—R. C. **Tolman**, S. **Karrer**, and E. W. **Guernsey**: Further experiments on the mass of the electric carrier in metals. A hollow copper cylinder was rotated inside a coil of 60 miles of copper wire (0·1 mm. in diameter), which served as the secondary of a transformer. The secondary was connected through an amplifier to a vibration galvanometer. The inertia of the electrons in the rotating cylinder causes them to lag and sets up an E.M.F. detected by the galvanometer. The deflections obtained were compared with those caused by the known E.M.F. accompanying transverse oscillation of the cylinder in the earth's magnetic field. The average value for m/e was $5{\cdot}18 \times 10^{-8}$ grams per abcoulomb, indicating that the mass of the carrier in copper is about the same as that of an electron in free space.—T. H. **Morgan**: Removal of the block to self-fertilisation in the ascidian Ciona. Eggs of *Ciona intestinalis* can be fertilised with sperm from the same individual if the egg-membranes are removed. The normal obstacle to self-fertilisation is the test-cells (between the membranes and the ovum) or something secreted by them; these cells are produced by maternal tissue and not from the ovum.—H. W. **Brinkmann**: On Riemann spaces conformal to Einstein spaces.

Official Publications Received.

The National Physical Laboratory. Report for the Year 1922. (Published for the Department of Scientific and Industrial Research.) Pp. 227. (London: H.M. Stationery Office.) 9s. net.

Mysore Geological Department Records. Vol. 20, 1921. Part 2. Pp. viii+167. (Bangalore: Government Press.) 2 rupees.

Bulletin of the National Research Council. Vol. 6, Part 1, No. 32: Proceedings of the Second Annual Meeting of the Advisory Board on Highway Research, Division of Engineering, National Research Council, held at Washington, D.C., November 23, 1922. Edited by William Kendrick Hatt. Pp. 89. (Washington: National Academy of Sciences.) 1.25 dollars.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Antigua, 1921–22. Pp. iv+19. (Barbados.) 6d.

Department of Commerce: Scientific Papers of the Bureau of Standards. No. 468: Formulas and Tables for the Calculation of the Inductance of Coils of Polygonal Form. By Frederick W. Grover. Pp. 737-762. 10 cents. No. 471: Methods of Measurement of Properties of Electrical Insulating Materials. By J. H. Dellinger and J. L. Preston. Pp. 39-72. 15 cents. (Washington: Government Printing Office.)

United States Department of Agriculture. Department Bulletin No. 1151: Silver-Fox Farming. By Frank G. Ashbrook. Pp. 60+4 plates. (Washington: Government Printing Office.) 15 cents.

The Rockefeller Institute for Medical Research — Organisation and Equipment. Pp. 25. (New York.)

Report for 1922 on the Lancashire Sea-Fisheries Laboratory at the University of Liverpool, and the Sea-Fish Hatchery at Piel. (No. 31.) Edited by Prof. James Johnstone. Pp. 99+6 plates. (Liverpool.)

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 46. Edited by Prof. Walter Howchin, assisted by Arthur M. Lea. Pp. viii+676+42 plates. (Adelaide.) 22s.

Royal Society of South Australia. Index to the Transactions, Proceedings, and Reports, Vols. 25-44, 1901–1920, and to the Memoirs, Vols. 1-2, 1899–1912. Pp. 189. (Adelaide.) 5s.

Fifty-Fourth Annual Report of the Trustees of the American Museum of Natural History for the Year 1922. Pp. xx+263+15 plates. (New York City.)

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1923. 89e année. Pp. 98+293+8 plates. (Bruxelles: M. Lamertin.)

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1922. Pp. 15. (Entebbe.)

SATURDAY, JULY 28, 1923.

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Large Scale Research in Abstract Science.

SEVERAL recent lectures and addresses have given prominence to the interconnexion between abstract science and industry and the marked influence of science on industrial progress. Among these may be mentioned two addresses by Sir J. J. Thomson, the first at the opening of the new laboratories of the General Electric Company at Wembley and the second from the chair as president of the Institute of Physics, the James Forest lecture of the Institution of Civil Engineers, and, most recent of all, the fourteenth Kelvin lecture of the Institution of Electrical Engineers by Prof. J. A. Fleming.

Prof. Fleming deals with problems in telephony, solved and unsolved, and illustrates in a remarkable way and with great knowledge and insight the consequences of scientific inquiry in the past, and the need for further researches in the future. Graham Bell died last year; Kelvin in 1876 had returned from the American Centennial Exhibition at Philadelphia to take the chair of Section A of the British Association at Glasgow, full of the invention of the telephone, which he described in his own inimitable manner, and Prof. Fleming, who forty-six years ago had been one of his audience at Glasgow, writes:

"In the year, therefore, following that of the decease of the illustrious inventor of the speaking telephone it is perhaps appropriate that the Kelvin Lecture should direct attention to some of the problems of telephony which have been solved or which remain unsolved."

The solved problems are sufficiently wonderful; the amplitude of the air vibrations in a just audible sound varies from about 10^{-8} cm. at a frequency of (say) 256 to rather more than 10^{-11} cm. at the highest audible frequencies, and minute motions such as these are impressed on the telephone diaphragm, translated into the variations of an electric current, transmitted to a distance, there amplified, communicated to the receiver, and from it to the observer's ear. Fleming's Kelvin lecture is a fascinating story of the many steps by which this has been achieved, showing how by degrees workers in various lands have each contributed their quota to the advance and made speech possible over 2000 or perhaps 3000 miles by aerial lines, 500 miles by underground, and 200 miles by submarine cables.

This progress rests on the theoretical investigation by Heaviside of the conditions for undistorted transmission, the application of this work, with successive improvements, by Pupin and Krarup and others to the loading of cables and the advances available by the use of the thermionic valve as an amplifier

and as the originator of "carrier" waves, rendering possible multiple telephony.

For the application of the valve as a rectifier of electric currents, we have to thank Fleming himself, while its whole action depends on the properties of the electron and the discoveries of J. J. Thomson. By the use of the valve as a repeater, many ingenious relays, the outcome of long and difficult investigations, have been placed in a secondary position; the lecturer explains in some detail how, by the selection of the suitable part of its characteristic curve, variations in the grid voltage can be impressed on the plate current and amplified by a transformer, while if another portion of the characteristic be employed, carrier wave multiple telephony is realised. In this "frequency filters" are employed—short circuits containing capacity and inductance which allow only those currents in which the frequency lies between certain limits to enter the line. The broad principles of the method are outlined thus:

"At one end of an existing long-distance telephone line used in the ordinary way for telephonic speech we can attach a certain number of modulating valves with their plate circuits coupled to the line with their appropriate transformers and filters. We can then generate by means of a number of oscillating valves high frequency currents of certain different frequencies and apply the electromotive forces due to these in series with the electromotive forces of low or speech frequency produced by ordinary carbon microphone transmitters so as to give to the grids of the several modulating valves carrier frequency plus voice frequency voltages. At the receiving end we separate out the several groups of oscillations by suitable band filters and apply the electromotive forces produced by suitable transformers to the grids of demodulating valves. In the plate circuits of these last valves we have coupled ordinary telephone receivers actuated by the voice currents disentangled by these demodulating valves from their respective carrier circuits."

Such has been the progress of less than fifty years. Fleming asks somewhat despondingly what is being done now in Great Britain. He refers to the laboratories of the great technical corporations of the United States, the American Telephone and Telegraph Company, the Western Electric Company, and the General Electric Company, giving an account of their activities in almost the same terms as those employed by Sir J. J. Thomson in his address to the Institute of Physics. "They retain," he writes, "the services of scientific investigators of the highest ability, who direct their attention not exclusively to problems of immediate commercial advantage, but look far ahead into the possible requirements of the future." Sir J. J. Thomson described two of these laboratories as seen by him during his recent visit to the United States. He found men at work on the most abstruse questions of physics—one need only mention Langmuir and the properties of the atom, or Coolidge and the investigations which led to the development of the Coolidge tube. There were numerous staffs of skilled assistants, some no doubt engaged in solving conundrums put to them by puzzled works managers, but many others searching deep into the secrets of Nature in the endeavour to find out new truths and to advance natural knowledge. Funds were practically unstinted, for the business directors of the works had found that by this means only could they extend the sphere of their activities and provide the dividends called for by their shareholders. In the United States abstract science has been made to pay.

Or to turn to another subject and another speaker. Quite recently the Wilbur Wright lecture, established by the Royal Aeronautical Society in memory of the American pioneer of aviation, was delivered in London by Prof. Ames, of the Johns Hopkins University. Prof. Ames is the chairman of the Executive Committee of the National Advisory Committee for Aeronautics of the United States, and directs the experimental work—full scale and model—of that committee at Langley Field. He has realised very fully the importance of an accurate knowledge of the air pressures on any part of aircraft undergoing manœuvres in the air; we were well aware of this, and years ago had done model experiments at the National Physical Laboratory, while at Farnborough apparatus for use in the air had been devised and some few experiments made. Prof. Ames showed slides illustrating in a most striking way the results obtained both on aeroplanes and airships, leading to information in the case of the latter which the Aeronautical Research Committee has pressed for many times, and which, had it been available in time, should have prevented the accident to the British airship R38.

Nor is this all: instruments have been successfully constructed which permit all the elements which contribute to a knowledge of the flight of an aeroplane—its velocities, accelerations, and the stresses to which its various parts are subject in the air—to be recorded during its flight. Instruments corresponding to some of these, such as the quartz-fibre accelerometer or the control force measuring stick, have been in existence at the Royal Aircraft Establishment for years; instruments corresponding to all have been planned and are in various stages of construction. In the United States they have found a man gifted with the knowledge to realise their need and with the authority to give effect to his knowledge. In England we have lagged behind.

So it is in other subjects; Great Britain is a small country, it is true, compared with the United States.

We owe much—in more senses than one—to our transatlantic kinsfolk, and we are piling up a debt which will prove more serious than the millions of the funding loan. What are we doing, what can we do, to reduce the load, to equalise the position ?

The General Electric Company has its new laboratories at Wembley finely equipped and guided in the proper spirit. "The question," Mr. Paterson writes, "is sometimes asked whether the laboratories undertake pure research or confine themselves to applied research," and his answer is that "the question is meaningless." "A research laboratory," he holds, "is not complete unless it contains members interested in almost every branch of science and provides facilities for these and also for other classes of work."

The National Physical Laboratory devotes much of the energy of its staff to abstract science, though telegraphy and telephony have not figured largely in its programme; these are catered for to some extent by the Post Office Research Laboratory at Dollis Hill. For metallurgical work we have the Brown Firth research laboratories and the Hadfield Laboratory at Sheffield; other firms have laboratories in which occasionally an investigation in pure science is carried out. But as a rule a work's laboratory is mainly occupied in controlling the normal product of the works, testing the materials supplied, and assisting the works managers in maintaining a proper standard.

Then there are the laboratories of the Research Associations established and in part financed by the Department of Scientific and Industrial Research; good and valuable work is being done by these, but the co-operative system has its obvious disadvantages, and in but few is abstract science pressed very far.

Our best hope for the future would seem to be with the universities, but here again the want of funds is an almost fatal handicap. "There is not," writes Prof. Fleming, "as far as I am aware a single university in this country which possesses the necessary equipment for conducting advanced experimental research in telephony and telegraphy"; and this is true of many other subjects.

Research is terribly expensive. We have always had men of the highest scientific originality who in the past have been pioneers in the advance of knowledge; we have them still, but somehow we fail to estimate their value; we are reluctant to furnish them with the means alone by which their natural gifts may be utilised. The application of science can be organised, and many steps have been taken in recent years to improve its organisation, but if we wish to utilise scientific progress to prevent waste and to increase the efficiency of industry we must support the solitary genius working often for a mere pittance in some university or college laboratory and devoting all his powers to unravelling a little further the tangled skein of Nature's mysteries. Success in the struggle depends on finding the right man and in affording him full facilities. We have the men; will our legislators who control the nation's purse see that facilities are not wanting for their work ?

R. T. Glazebrook.

An Epitome of Antarctic Adventure.

The Life of Sir Ernest Shackleton, C.V.O., O.B.E. (Mil.), LL.D. By Hugh Robert Mill. Pp. xv + 312 + 20 plates. (London: William Heinemann, Ltd., 1923.) 21*s.* net.

By common consent, Dr. Hugh Robert Mill, the author of "The Siege of the South Pole" and the friend and adviser of a generation of polar explorers, must be acclaimed the right man to tell us the story of the most brilliant career in modern Antarctic exploration. Not only has he long been the ablest chronicler and the most sympathetic critic of adventure and achievement in the southern seas, but he was also for long the friend and oftentimes the confidant of the subject of this biography. It was, therefore, with the keenest anticipation that we took up the book, anxious to see how a master hand would deal with a life so full of light and shade and a character compounded of such contrary impulses. The result is somewhat of a revelation, and whatever may be said in criticism of the book it must be acknowledged that the biographer has carried out his task worthily and has revealed to us the man as he was, fully and fairly. It was obviously no light task to reconcile the leader of magnificent sledge journeys with the unsuccessful dabbler in city finance, the platform lecturer, unconventional even to bluntness, with the sensitive lover of poetry, but it has been done with skill and understanding and the result will be to many a new Shackleton, undreamt of by those who knew but one of his many aspects.

The book is divided into three sections corresponding with somewhat indefinite periods in the life. In the first, styled "Equipment," we are introduced to a healthily mischievous boy with a taste for poetry and the sea, developing along normal lines into an efficient but scarcely an enthusiastic officer of the mercantile marine. So far the story is an ordinary one, and even to Dr. Mill's discerning eyes it foreshadows but little of the future. But then appears the nucleus round which his energy and ambition gathered. To the average reader the story becomes alive immediately

his future wife appears on the scene and stirs him to an incentive which in his own words at the time is expressed by the wish "to make a name for myself and for her," though as yet the sphere of fame had not been selected.

The chance came with his appointment to the *Discovery* expedition, and he seized it with both hands. Though but a junior officer he was selected for the most important journey, and under the hardest conditions he learnt the manifold tricks of the sledger's trade. How well he learnt them was to be seen some six years later when he took his own expedition south equipped with improvements on the *Discovery* arrangements in every direction. Compared to his own ventures, that of the National Antarctic Expedition was perhaps a little rigid in character, a little complex both in resources and aims, and a little embarrassed by committee control from home. We find Shackleton going to the opposite extreme in these matters, and generally with success, but we believe he had much to thank his first polar school for, if it can be called a school when all were learning and no one taught. The apprenticeship to Antarctic service is followed by shore jobs and a life varied in the extreme, a period through which the biographer takes us most successfully and indeed humorously, concluding the first part of the book with what must have been most excellent training, Shackleton's unsuccessful candidature for the general election of 1906.

Then comes "Achievement," the thrilling story of the multiple successes of his *Nimrod* expedition, a story hitherto told only in Shackleton's own words and therefore affording scope for the biographer to add many new and personal notes which explain actions formerly incomprehensible. Such, for example, was his repeated endeavour to seek a base on King Edward Land, not because his judgment selected it but because of a compact with Scott. How heavily this promise weighed upon him is seen in one of the gems of the book, a quotation from his letter written at the time of the decision—forced upon him by circumstances—to go back upon a promise which bound him too hardly. The journeys that follow, the triumphs of organisation and endurance which make up the history of that expedition, are well and fairly told. Records were broken in all directions, and from the popular point of view it was indeed the achievement of the whole career. From the point of view of the student of character and of the discerning reader of polar literature it was not the climax, which was to come eight years later. Served by his great ability, mental as well as physical, and aided by what he himself liked to call his luck, but which was largely his own foresight, he went magnificently far. Yet, in a sense, he went no farther than many another great leader has gone, with a similar fortitude, that is to say, to the limit of safety. To our mind the true ability of his leadership was not shown until he had gone farther than safety permitted and yet brought back his men in safety. None will dare belittle the triumph, but we believe that posterity will regard the management of the retreat of the *Endurance* party as his masterpiece and not the attainment of the heart of the Antarctic.

In the chapters which follow, headed "Popularity" and "Unrest," the biographer records faithfully the honours by kings and emperors, the triumphal progress of lecture tours, and the ups and downs of precarious finance. These things had to be recorded since they were part of Shackleton's life, but one is impatient all the time to get away from an atmosphere which never really suited him however brilliantly he shone in it on occasion.

Then comes the third part of the book, "Bafflement," a title true enough in a popular sense, for the rebuffs of fate were now well-nigh continuous, but scarcely comprehensive enough to indicate the real essence of this period of his life, the paradox of lasting fame arising from apparent failure. The story of the *Endurance*, already well, if tersely, told by Shackleton himself, gains colour in the hands of this master of narrative, and so too does our picture of the man, always at his best when with his back to the wall. Of polar travel it may be said more truly than of most ventures that any fool can get into a tight place but that it takes a man to get out of it again. Paraphrasing, we may say that most polar leaders have dared to the utmost as Shackleton did, many have achieved the utmost limit of endurance as he did, but few indeed have retreated in good order from an almost hopeless position. One has only to read the long list of ghastly retreats in polar history to imagine what might have happened, and then to admire the hand that grew firmer and the spirit that grew more courageous as the outlook grew darker. The chapter concluding the account of the *Endurance* expedition would have been an artistic ending to the book had it been possible. Not that great service was not yet to come, but the story now becomes diffuse with the welter of war, and the man is but one of many instead of at the head of a few. The story of the *Quest* inconclusive so far as the man is concerned, and is brief. It shows Shackleton with the same extraordinary capacity for organisation and the same magnetic personality ensuring support from unexpected quarters and rallying most diverse elements round him. At the same time it shows his judgment somewhat dimmed or perhaps merely harried by considerations

of finance and season, which hurried him off before his ship was really seaworthy.

The epilogue which closes the book is in Dr. Mill's very best style, and in many ways it gives us a clearer picture of the man than the recital of his deeds has done.

The book is a very notable addition to the library of Antarctic literature which the author has already enriched, and is singularly free from errors. We cannot miss the rare luxury of correcting Dr. Mill on points of fact, as for example on p. 68, where for "sea-ice" we should read "barrier-ice," or on p. 139, where for "2000 feet" given as the height of the gap between Mt. Hope and the mainland we should read "900 feet." Another slip of the pen is on p. 243, where the return journey of Mackintosh's party over the Barrier is described as "more trying even than that of Captain Scott." Otherwise all comparisons are wisely avoided, nor is an attempt made to assess the value of the life's work, which great as it was cannot be viewed as yet in its true perspective. More might have been said as to the character of the innovations made by Shackleton into polar work, from the point of view both of organisation and of methods of travel, though this was probably omitted as being too technical a subject for the book. If the first object of a biography is to enlist the sympathy of the reader for the man then the book is a signal success, for no one can read without emotion the vivid pictures of his doings and writings in so skilful a setting, and if excuse were needed for this biography at all it would lie in the fact that in the rapidly changing circumstances of polar organisation we may never again see such a man leading single-handed ventures to great success or triumphant failure.

F. DEBENHAM.

The Physics of the X-Rays.

Les Rayons X. Par Maurice de Broglie. (Recueil des Conférences-Rapports de Documentation sur la Physique. Vol. 1. 1re Série, Conférences 1, 2, 3. Édité par la Société *Journal de Physique.*) Pp. 164 + 5 planches. (Paris : Les Presses Universitaires de France, 1922.) 15 francs.

THE present volume is the first of a series of reports on physics edited by the French Physical Society and issued under the direction of an influential committee representing nearly a dozen institutions and societies in France. Each report is discussed at a number of conferences which are open to the public, and the report in its final form is published for the benefit of men of science, technicians, students, and others, who wish to make themselves *au courant* with the recent developments of the particular branch of knowledge in question. That such a scheme should be set afoot is not the least of a number of indications of a great scientific revival which our neighbours across the Channel are for their part endeavouring to stimulate.

A similar scheme has been initiated in the United States under the direction of the National Research Council, and already a number of volumes have been published. If we except the admirable reports published by the Physical Society of London, we cannot recall any similar organised endeavour in Great Britain to sum up the present state of knowledge in the various departments of science. Nevertheless, much has already been done by individual effort—as is perhaps the British way—and a number of British workers have already published valuable monographs on the various sections of physics with which their names are associated.

If the book before us is an earnest of the standard of attainment in the volumes still to come, there will be a warm welcome for the new series, which, we are informed, will deal with such subjects as the quantum theory, the electric arc, the structure of crystals, thermionics, etc.

The treatment adopted by the Duc de Broglie is a revelation of the amazing achievements of the X-rays in atomic physics, and provides many indications of the ramifications of the subject into many departments of physics and chemistry. For example, the opening pages contain an attractive discussion of Bohr's theory of the atom, Moseley's law of atomic numbers, and the part the quantum theory plays in the phenomena of radiation.

One is reminded that formerly the X-ray worker was unequipped with a precise means of sorting out the various qualities of X-rays with which he experimented. His only recourse was filtering through metal screens — a method which is relatively crude and ineffective for the purpose, and, indeed, served to mask a number of relations the real meaning of which can only now be appreciated. Nevertheless, by the insight of Barkla and others, several great and general truths were discerned, which laid the foundations of the subject as it has since developed.

A new era dawned with the discovery of the dispersion of X-rays by crystals. The new science of X-ray spectrometry sprang into being and at once turned to account the technique and precision of the older optical spectrometry. Valuable as the work on the analysis of the spectral lines of the optical spectra had proved to be, it was transcended in simplicity and potency by the newer spectrometry. To the literature on X-ray spectrometry the Duc de Broglie has himself contributed in notable measure, and his

account of the subject is correspondingly "alive" and authoritative.

Among much that calls for comment in this book is a good account of a variety of metal X-ray tubes which have so far been used chiefly in spectrometry. The recent researches which have filled the gap of 4 octaves between the former boundaries of the ultra-violet spectrum and the X-ray spectrum receive full attention.

One of the more recent triumphs of X-rays in the field of atomic physics is the work of the Duc de Broglie on the speed of the secondary electrons excited when X-rays fall upon matter. The speed was displayed by the method of the "magnetic spectrum"; and using X-rays of a specific wave-length, de Broglie was able to show that the secondary electrons arranged themselves into well-defined groups which had been ejected respectively from the K, L, M, etc. rings of the atoms of the material. These results, which receive simple explanation on the quantum theory and that of Bohr, have been confirmed in Great Britain by Whiddington, and widely extended at the Cavendish Laboratory by Ellis, who used radium γ-rays of much shorter wave-length than can at present be generated artificially. The present volume contains an interesting account of these enthralling investigations.

There are many valuable tables of wave-lengths, etc. in the book, and a number of plates showing some fine examples of X-ray emission and absorption spectra. At the end of each chapter there is a good bibliography. In accordance with French custom there is no index, but tradition is scouted by the provision of a serviceable stiff cover, a feature which will make its appeal in other countries.

G. W. C. KAYE.

Elementary Zoology.

Essentials of Zoology for Students of Medicine and First Year Students of Science. By Prof. A. Meek. Pp. xii+325. (London: Longmans, Green and Co., 1922.) 10*s.* 6*d.* net.

THE volume before us, intended for students of medicine and first-year students of science, is written by one who retains his belief in the "type system," and clearly has no sympathy with those who believe that this method of teaching, unless used with great discretion, is liable to do much to kill the student's interest in his subject.

The book consists of ten chapters, each devoted to one of the more important divisions of the animal kingdom. The chapter on Protozoa commences with short descriptions of Amœba, Paramecium, Vorticella, Cercomonas; these are followed by a section dealing with general considerations such as morphology, physiology, psychology, reproduction, symbiosis; and the chapter concludes with an account of important parasitic types—Opalina, Monocystis, Plasmodium, Trypanosoma. The descriptions of the various types are short and concise, but we notice a number of sentences which are liable to mislead the elementary student: such statements as that the trypanosome "progresses by the action of the flagellum which is *posterior*," that the recrudescence of malarial attacks is due to the female gametocyte developing parthenogenetically, that the fully grown "Plasmodium" becomes crescentic, require qualification or emendation.

The chapter on Cœlenterata deals with Hydra and Obelia, that on Platyhelmia with Distoma and Tænia, that on Mollusca with Anodonta, that on Annelida with Lumbricus and Nereis, that on Crustacea with Nephrops, that on Insecta with Blatta, Anopheles, Culex, and Glossina. We are glad to see our old friend Amphioxus accorded the dignity of a special chapter. The chapter entitled Pisces deals with the skate, and that entitled Amphibia with the frog. This is followed by a chapter on the development of birds and mammals, and the book ends with a chapter on Mammalia, dealing mainly with the rabbit.

As in the Protozoan chapter, so also in other parts of the book, we notice many statements that might with advantage be emended in a new edition. It is not accurate to say the gastrula is a stage in the development of *all* the metazoa. It would be wise to use the word solenocyte in the sense defined by its inventor. The expression "schizocœl *or* mesenchyme" is liable to lead the careless student to think these terms are synonymous. Such statements as "the myocœl develops a sclerotome," "the longitudinal valve [of the frog's conus arteriosus] is disposed in a slightly spiral direction from the right anterior aspect to near the left of the median line posteriorly," "the skeletal muscular system is derived from the . . . *myocœl* of the cœlomic mesoderm," "species of Rana are used for food . . . and large numbers are *employed* in zoological and physiological laboratories" (the italics are ours), are, to say the least, awkwardly expressed.

Such statements as we have quoted indicate that the book would have been the better for more careful revision before going to press. Notwithstanding such blemishes in detail we are of opinion that the book will prove useful to the class of student for whom it is intended. It is illustrated by numerous figures, somewhat rough in execution but for the most part clear and intelligible as well as accurate.

Arabia and Arab Alliances.

The Heart of Arabia: A Record of Travel and Exploration. By H. St. J. B. Philby. In 2 vols. Vol. 1. Pp. xxiii + 386. Vol. 2. Pp. vii + 354. (London: Constable and Co., Ltd., 1922.) 63*s*.

IN October 1917, Mr. Philby found himself the sole representative of Britain in the heart of Arabia on a mission which was organised, with the encouragement afforded by the initial success of the movement against the Turks on the Hejaz, to carry messages of goodwill to the ruling chief of Wahabiland. The co-operation of the latter was to be invited in giving effect to the Euphrates blockade against the Turks, and ultimately to launch a campaign against that very able ally of Turkey, Ibn Rashid of Hail. At the back of it there was no doubt some Utopian ideal of a united Arabia. The ruling chief of Wahabiland (which may be said to include all Najd, or Central Arabia, together with the coast province of Al Hasa bordering the Persian Gulf) was Imam Ibn Sa'ud of Riadh, and it was to Riadh that Mr. Philby's mission was directed, *via* Hofhuf, the capital of Al Hasa, from a port on the Persian Gulf coast opposite Bahrein.

At Riadh, Mr. Philby, who seems able to adapt himself most effectively, not only to Arab clothes, but also to Arab sentiment and the idiosyncrasies of the Arab people, and appears to be perfectly at home in the desert as in the town, secured the friendship of Ibn Sa'ud, and was certainly greatly indebted to that chief for his safety and success while traversing the country. The hospitality and almost invariable expression of goodwill which were extended to him throughout his travels were due not merely to the world-old traditions of the Bedouin but also to the influence of Ibn Sa'ud, who is obviously a most enlightened and competent ruler of a vast territory. At Riadh, Mr. Philby enjoyed the opportunity of giving us an excellent account of the city itself and of the character of the Wahabi faith as professed by its most ardent disciples—all of it most interesting and valuable information. But he failed to meet the British envoy who was to have brought from the west, from the Sharif of Mecca, messages of reconciliation with Ibn Sa'ud, who was known to be bitterly jealous of the Sharif. Nothing, indeed, roused the indignation of Ibn Sa'ud so effectively as that the Sharif of Mecca should assume the title of King of Arabia. All this, of course, is ancient history by this time, and the course of dramatic events which occurred more recently in the Hejaz is modern enough to be within the recollection of most of us. At the time, however, Mr. Philby's immediate movements were determined by the attitude of the Sharif, who simply declined to allow the British envoy to proceed to Riadh. In these circumstances, Mr. Philby decided to go to Taif himself and fetch him. In this, however, he was disappointed, although it led to a journey by the pilgrim road to Jeddah, passing within a measurable distance of Mecca and including a visit to Taif. The Sharif was absolutely hostile to any proposition of alliance with Ibn Sa'ud, and thus fell through the hoped-for unity between Central and West Arabia. Mr. Philby, who gives us a most interesting story of his travel by a route which is little enough known, was obliged to return to Mesopotamia by sea from Jeddah.

It was not long, however, before Mr. Philby found himself once again in Riadh, this time with the object of initiating an active campaign against Ibn Rashid, the Turks' ally at Hail. It was while he was waiting for Ibn Sa'ud to complete the preparations for this expedition (which afterwards proved more or less abortive and involved the death of that brilliant young explorer, Capt. Shakespeare) that Mr. Philby undertook what was by far the most interesting geographical exploration that has been made for many years in Arabia, which carried him as far south as the Wadi Dewasir, nearly to the edge of the great southern desert. He was still within the limits of the Riadh administration, but the influence of it grew weaker the farther he penetrated south, and it was at an important place in the Dawasir oasis, with the ominous name of Dam, that he encountered fanatical hostility, which, but for his tact and energy, might well have brought his career to an untimely end. Many points of especial interest attracted his close attention. The ruins at Kharj, the remains of the tombs of a long-forgotten race, are especially interesting in connexion with those at Bahrein, which were first examined and opened by Durand (Sir Edward of that ilk), whose description of them in the pages of the Journal of the Royal Asiatic Society is far more instructive than that of Theodore Bent (who followed him some years later), and points to a constructive resemblance with those of Kharj which cannot be accidental.

Mr. Philby devotes a chapter to destructive criticism of the delightful romances of Arabian adventure written by William Gifford Palgrave. Apparently he did not previously know (as certainly Mr. D. G. Hogarth, who questions Mr. Philby's conclusion, could not have known) that Palgrave had long been without honour among geographers of the Persian Gulf as a veracious narrator. Palgrave was a Jesuit father, true apparently to the traditions of his order, for, while we must render all honour to those early Jesuit missionaries who were the very first pioneers in the field of Asiatic geography, no one who has endeavoured to unravel their itineraries by the light of more modern determinations can fail to observe their skill in the

art of geographical embroidery. We might even repeat Mr. Philby's remark that some of their statements "bear no ponderable relation to fact."

"The Heart of Arabia" must be reckoned as a most valuable addition to the literary efforts that the mysteries of Arabia have called forth. There is always the danger in a work of this sort of descriptive narrative lapsing into the style of the official route report. This is most skilfully avoided by the author in his story of everyday happenings in a society which is as old as that of the patriarchs, and still exists in its patriarchal form. Mr. Philby is much to be congratulated on his remarkable experiences and his manner of telling them.

T. H. HOLDICH.

Our Bookshelf.

Flavouring Materials: Natural and Synthetic. By A. Clarke. (Oxford Technical Publications.) Pp. xxi + 166. (London: Henry Frowde and Hodder and Stoughton, 1922.) 8*s.* 6*d.* net.

THE manufacturer of foods and beverages, whose demands have created the infinite variety of flavouring materials now available, is a person with a remarkably catholic taste, since he appears to take into account anything with a flavour, from aloes to lemons, as possible materials for making his wares attractive. While laying the rose under contribution, he is apparently not averse from keeping scatole in his mind's eye as a possible means of titillating pleasantly the olfactory nerves of his clients. It is quite clear when such unpromising materials as some of these, not to mention colocynth and senna, which the average man regards as particularly nauseous drugs, can be seriously considered as ingredients in foods and beverages designed to be pleasant, that flavouring has become an art which requires its own experts and its own literature.

Mr. Clark's contribution, which he modestly describes as notes accumulated during a number of years' work in a technical capacity in the foodstuff and beverage trades, is a good beginning, and gives within small compass a mass of useful information regarding spices and condiments, the methods used in determining their quality, and the best ways of baulking the wily sophisticator who substitutes ground date or olive stones for powdered cinnamon or ginger. But spices in their natural state are no longer the only materials on which the flavouring expert can draw, and a considerable part of the book is devoted to a summary of the characteristics of purely chemical substances, extracted from essential oils or made in the factory. The particular part they can play in compounding flavours is described, and the things they may or may not be blended with are duly recorded.

The statements regarding each product are reasonably complete, and where further information is required references to original literature are given. Altogether the book is a good example of what technical literature of this kind should be, and though it would be easy to find points in it that are objectionable from a purely scientific point of view, they are not likely to mislead the reader for whom the book has been compiled.

T. A. H.

The Theory of Emulsions and Emulsification. By Dr. William Clayton. (Text-books of Chemical Research and Engineering.) Pp. viii + 160. (London: J. and A. Churchill, 1923.) 9*s.* 6*d.* net.

DR. CLAYTON's book is a fitting sequel to earlier issues of the series of "Text-books of Chemical Research and Engineering" to which it belongs. These have included volumes on molecular physics, the physics and chemistry of colloids, surface tension, catalysis, and catalytic hydrogenation. The skilful blending of advanced theory with advanced practice which characterises Dr. Clayton's book is therefore by no means a novel feature of these text-books. The author claims that his chief aim has been "to follow a logical line of development based on modern physico-chemical principles," and that "technical applications of emulsions have only been introduced either as illustrating some particular laboratory method on a large scale or because some important theoretical point is involved."

While, however, much of the book is actually devoted to theory, the practical aspects of emulsion-making and emulsion-breaking are very far from being neglected. Indeed, one of the most striking features of the later chapters is the large number of references to patents covering processes for carrying out these contrary operations. One of the most important applications of the process of emulsion-making is the homogenising of milk and cream. A process whereby new milk of 4 per cent. fat content acquires the appearance of a cream containing 8 per cent. fat, while a 15 per cent. cream becomes a good substitute for a 25 per cent. cream, has obvious attractions. The opposite process of breaking emulsions is an important operation in the initial treatment of crude mineral oils; but it is also important in the de-oiling of condensed steam, as well as in the more familiar operation of separating cream from milk and converting it into butter. The book contains a bibliography of nearly 200 papers dealing with emulsions and marks a new era in the scientific study of a subject which has very important practical applications.

T. M. L.

Mathematics for Students of Agriculture. By Prof. S. E. Rasor. Pp. viii + 290. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 16*s.* net.

EVERY indication that mathematics is assuming a more prominent position in the curriculum of students of agriculture is very welcome. The mathematical requirements of the agricultural student are roughly twofold. First, he requires a knowledge of simple calculations applicable to the routine problems of fertilisers, feeding stuffs, surveying, buildings, book-keeping, etc. Secondly, he very urgently requires an elementary understanding of statistical methods and probabilities applicable to the interpretation of experimental results. Prof. Rasor's book deals mainly with the first of these requirements. The value of the book to agricultural students approaching mathematics

for the first time would be enhanced if less prominence were given to formal definition and more to simple explanation, but there is no doubt about the usefulness of this book to the student who wishes expeditiously to revise and amplify previous work. It is concise, well indexed, and contains a large number of exercises. Some of the latter might profitably be revised. The statement in Exercise 5 on p. 13 that in a certain fertiliser "43⅝ per cent. is phosphoric acid (phosphorus)" will doubtless annoy the chemist. In the same exercise the student is asked to calculate how much acid phosphate containing 16 per cent. phosphoric acid is required, when mixed with cotton seed meal and kainit, to provide a mixture containing 43⅝ per cent. phosphoric acid. A practicable answer to this question might be the salvation of agriculture.

Unfortunately the use of American data and money units detracts from the value of the book to students elsewhere. N. M. C.

(1) *A Canadian School Geography.* By Prof. G. A. Cornish. Pp. xiv+450. n.p. (2) *The Canadian School Atlas.* Prepared at the Edinburgh Geographical Institute under the Editorship of Prof. G. A. Cornish. Pp. v+65 maps+16. n.p. (Toronto: J. M. Dent and Sons, Ltd., 1922.)

(1) THE best features of this work are the maps, illustrations, and practical exercises. For the rest the book is planned on somewhat orthodox lines. Too much is attempted in the space available, so that in places the book gives little more than a catalogue of uncorrelated facts. It is certainly most informative, especially with regard to Canada, to which a large part of the book is devoted, but on the whole the geographical outlook is wanting.

(2) The atlas was prepared in the first instance to be used with this text-book, but may easily make a wider appeal as a general reference atlas for use in Canada. It contains forty-eight pages of finely executed maps by Bartholomew and a full index. Fourteen pages are devoted to maps of Canada, of which the most populated parts are shown on scales of 1 : 2,500,000. The rest of the world is shown on small-scale maps, but there is a coloured orographical map of every continent. One improvement would be the addition of a larger scale map of India, but the atlas as a whole deserves high praise.

Nyasa, the Great Water: being a Description of the Lake and the Life of the People. By the Ven. William Percival Johnson. Pp. vii+204. (London: Oxford University Press, 1922.) 7s. 6d. net.

IN this volume, the Archdeacon of Nyasa has placed on record his knowledge of the lake and its people, among whom he has served for many years as a member of the Universities' Mission to Central Africa. In the preface, the Bishop of Oxford, with pardonable enthusiasm, says that it is unique and "a book which no student of 'backward' races can afford to leave unread." Its readers, perhaps, will not be prepared to go so far; but it is certainly a valuable and intimate study of the life and mentality, the customs, occupations, and beliefs of the Angoni, Wa Yao and Nyasa or Nyanza who live on the shores of the great lake Nyasa. The salient feature of the book is its keen insight into the native mind—a result which is achieved most markedly by means of the chapter of "village stories," in which the author has reported, in the words of the natives themselves, incidents of courage and helpfulness in the face of known and concrete danger. These he contrasts with the fear, leading to cruelty, arising out of the impalpable and unknown, which lies at the root of much of their religious ritual and belief.

Into the East: Notes on Burma and Malaya. By R. Curle. Pp. xxxi+224. (London: Macmillan and Co. Ltd., 1923.) 10s. net.

"CITIES (like persons)," says the author of this work, "have their idiosyncrasies that, slowly revealing themselves, layer upon layer, absorb you at last into their atmosphere," and goes on to ask what it is that the new-comer feels about Rangoon, in this particular instance, that to an inhabitant is second nature. Wherever his travels in the East have taken him, his purpose has been to seize the essentially differentiating quality in each place. He speaks of his book as a record of things seen and of things thought; but in the mind of the reader the latter will loom larger than the former, and in the retrospect, whether the author's words describe Colombo, Rangoon, Mandalay, the mining town of Kuala Lumpur, or the investiture of the Sultan of Perak with the K.C.M.G., it is their quality as an intensely personal record of impressions rather than as a statement of fact that will remain. In the end the author confesses himself baffled by the East, and its inscrutability and aloofness is perhaps the most vivid of the impressions he conveys to his readers. Mr. Joseph Conrad contributes a preface in which he discourses in characteristically alluring manner of travellers and of their works.

Abrégé de géographie physique. Par Prof. E. de Martonne. Pp. v+355. (Paris: Armand Colin, 1922.) 15 francs.

STUDENTS of geography will be glad to have this outline summary of M. de Martonne's well-known "Traité de géographie physique." The general plan is the same as in the larger work, but a new chapter has been added giving a sketch of the relations of human and physical geography. In order to make the treatment throughout the book as concrete as possible, the author has chosen under each heading the most striking aspects of the subject, wisely making no attempt to cover all the ground in a limited number of pages. The third section, "le relief du sol," is particularly lucid, and is illustrated by most instructive photographs and block diagrams. The bibliographical references to each section are well chosen, but why is there no index?

The Practical Electrician's Pocket Book for 1923. Twenty-fifth Annual Issue. Edited by H. T. Crewe. Pp. xci+571+Diary. (London: S. Rentell and Co., Ltd., 1923.) 3s. net.

A CHAPTER on "wireless" broadcasting has been added to this useful little book. Apparently some experimenters have difficulty in getting a good "earth," but the suggestion that they should get an old bath, solder the earth wire to it and then bury it, is in our opinion quite unnecessary.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Quantum in Atomic Astronomy.

THE approach to the quantum by the path of energy, though historically natural and probably inevitable, is scarcely the simplest mode of presenting it to students. So long as assumptions or guesses have to be made, as a supplement to ordinary dynamics when applied to events occurring in the interior of an atom, it is best to make them nakedly, so as not to cloak their character; and then to let experience justify them, and hope for subsequent theory to explain them. This is a procedure after the manner of Kepler. The following brief summary, though inadequate as an exposition, is sufficient to indicate the main points in what I imagine to be a slightly clarified mode of presentation.

Bohr assumed (virtually) that, in a family of electrons revolving round a nucleus, the rate of sweeping areas, $r^2 d\theta/dt$ or $r^2\omega$ constant for any one orbit, proceeded discontinuously in arithmetical progression from orbit to orbit. This supplied a kind of Bode's law for the succession of satellite electrons, not at all dissimilar from the actual rough succession of planetary orbits round the sun provided that some of the possible orbits may be left empty; as they conspicuously often are inside the atom.

The recognised expression for twice the rate of sweeping areas, for inverse-square motion round a centre of force, is

$$\sqrt{\mu a(1-\epsilon^2)}\,;$$

and this, multiplied by the mass of the revolving particle, is its moment of momentum mpv, with p the perpendicular on the tangent; also called angular momentum, $mr^2 d\theta/dt$.

Bohr's assumption is that in the atom this quantity can only exist discontinuously in indivisible units or atomic portions, say A, of which only integer multiples are possible; so that it equals nA. One would gladly use the letter h for twice the rate of describing areas, as usual, had not the symbol been otherwise monopolised, in this connexion, by a quantity which, though approached differently, turns out on arrival to be nearly the same.

Our first equation, then, is that

$$m\sqrt{\mu a(1-\epsilon^2)} = n\mathrm{A}.$$

The time period of an inverse-square orbit is well known as

$$\mathrm{T} = 2\pi\sqrt{\frac{a^3}{\mu}}\,;$$

and this is our second equation.

So, combining these two equations, and ignoring the excentricity ϵ as an unimportant and provisional detail, we get at once for the angular velocity in a permissible circular orbit,

$$\omega = \frac{2\pi}{\mathrm{T}} = \frac{\mu^2 m^3}{n^3 \mathrm{A}^3}\,;$$

μ being, as usual, the force intensity, or acceleration at unit distance, namely in the electrical case, $\mathrm{E}e/m$, or $r^3\omega^2$. For accuracy, m should be interpreted throughout as half the harmonic mean, $\mathrm{M}m/(\mathrm{M}+m)$, because the revolution is round the common centre of gravity.

But, in accordance with Bohr's assumption, $n\mathrm{A} = mr^2\omega$; so that $n\mathrm{A}\omega$ is energy, mv^2, or say $2\mathrm{W}$.

Energy is therefore proportional to frequency; and we can proceed to identify $\mathrm{A}\omega$ with Planck's $h\nu$, and find that the relation between the introduced constants is simply $h = 2\pi\mathrm{A}$, because $\omega = 2\pi\nu$.

Further, by remembering that whenever a particle falls in towards an inverse-square centre of force it gains twice the energy which it can retain in a circular orbit (though no dynamical reason can be given for its half-stopping and occupying such an orbit and ejecting its surplus energy), we get for the energy radiated, on Bohr's second assumption that radiation only occurs when electrons drop from orbit to orbit, the difference between $\frac{1}{2}n_1\mathrm{A}\omega_1$ and $\frac{1}{2}n_2\mathrm{A}\omega_2$; or

$$\mathrm{W}_1 - \mathrm{W}_2 = \frac{\mu^2 m^3}{2\mathrm{A}^2}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right).$$

Whence Rydberg's spectrum-frequency-constant, defined as the constant part of $\delta\mathrm{W}/h$, comes out in the alternative forms,

$$\mathrm{N} = \frac{\mu^2 m^3}{2\mathrm{A}^2 h} = \frac{2\pi^2\mathrm{E}^2 e^2 m}{h^3} = \frac{\mathrm{E}^2 e^2 m}{4\pi\mathrm{A}^3}\,;$$

of which the last seems to have some advantages.

OLIVER LODGE.

The Resolving Power of Microscopes on Test-plates for Microscopic Objectives.

IN letters published in NATURE (September 1, 1921, p. 10; February 16, p. 205, and May 27, 1922, p. 678) on the above-mentioned subjects, I gave an estimate of the limit of microscopic resolving power; that is, of the least distance which must exist between two points in the focal plane if they are to appear as separate points in the image. I mentioned half a wave-length of the illuminating light as its approximate value. I have now, however, reason to believe that this is an overestimate and that $0{\cdot}7\lambda$ is nearer the mark. This is in agreement both with a re-computation of the illumination near the image of a point and with observations made on the test plates.

The image of a bright point in the geometrical focus of a lens consists, as is well known, of a bright disc surrounded by rings, the dark spaces between which indicate the positions where the integral difference of the optical length of the rays from any part of the dark ring to the corresponding distance from the geometrical focus is half a wave-length.

In Fig. 1 let O be the geometrical focus and $O\gamma$ the

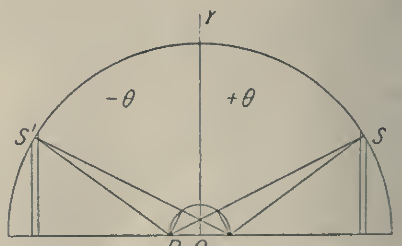

FIG. 1.

axis of the lens. Let SS' be a section of the spherical wave surface which by the action of the lens is converted into a second spherical surface with the same axis and with its centre at the conjugate focus. Let P be a point in the focal plane near O, and divide the surface SS' into elementary zones by planes to

which OP is normal. Consider a pair of such zones in latitudes $+\theta$ and $-\theta$ (taking the diametral plane as equatorial). Every point in each zone is at a constant distance from P, and the constant difference between PS and PS' is $2OP\sin\theta$. Assuming that the focal length OS is great compared with λ, and the conjugate focal length great compared to OS, then the difference of phase in the waves contributed to the image by each pair of zones is (if $OS=r$) $4\pi(r/\lambda)\sin\theta$. Putting A for the wave amplitude which would exist in the image if all the partial waves arrived in the same phase, and writing ϕ for $4\pi(r/\lambda)\sin\theta$, the actual amplitude at the geometrical conjugate focus of a point distant r from O is $A\int_{\theta_2}^{\theta_1}\cos(\phi/2)d\theta$, where θ_1 and θ_2 define the operative areas of the wave surface SS'. The value of A will be different for each pair of limits, but the ratio between the amplitude at O and that at r is $\int_{\theta_1}^{\theta_1}\cos(\phi/2)d\theta$. In computing this integral a table was formed for $\cos\phi/2$ between the limits 0 and 2 for r/λ, and 0 and $\pi/2$ for θ. Fair curves were drawn through the plotted values of $\cos\phi/2$ for each of the chosen values of θ (see Fig. 2)

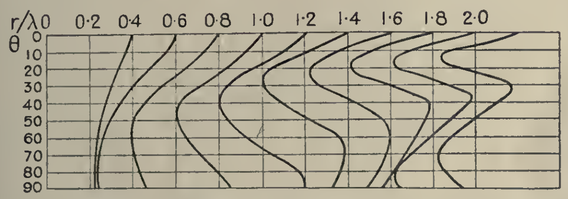

FIG. 2.—Horizontal lines measured from the curves to each of the principal verticals are the values of $\cos\phi/2$ (where $\phi=4\pi(r/\lambda)\sin\theta$) from $\theta=0$ to $\theta=\pi/2$, and the principal verticals refer to values of r/λ from 0 to 2.

and the algebraic area of the curves for various limiting values of θ was measured with a planimeter[1] (see Fig. 3). The intensities of the illumination are of course as the square of the amplitude.

When two or more luminous points in the focal plane are in proximity, the interference effects occurring between their ring systems are not independent of the nature of the illumination. If the luminous points radiate light proceeding from a single source, there is a definite phase relation among the emitted waves, and in this case the intensity is proportional to the square of the sum of the amplitudes; if, however, the points are self-luminous it is the sum of the squares which must be taken.

The change in the appearance in the field of a microscope when a point source is substituted for diffused light is very conspicuous.

The curves in Fig. 3 indicate that as the aperture of the lens is increased from 0 to 90° the diameters of the central disc and of the rings are reduced, as well as the relative brightness of the rings, and that when the whole hemisphere of the wave surface is operative the diameter of the central disc—*i.e.* the radius of the first dark ring—is a little greater than 0·4λ.

When the central rays are stopped out the diameter of the disc is still further reduced, but the brightness of the rings is greatly increased. Thus when only the marginal rays are effective the image of a single line will appear multiple.

It must be remembered that these curves only apply to points in the focal plane, and that the radii of the rings for points slightly out of focus are greater.

[1] For a somewhat similar purpose Airy (see his "Intensity of Light in the neighbourhood of a Caustic," Camb. Phil. Trans., vol. 6, pp. 379 *et seq.*) computed his table numerically by methods much more accurate, but also much more laborious, than the planimeter. The latter, however, is sufficiently good for the purpose of this note.

The lateral spectra which accompany the image of lines (which may be regarded as the envelope of the ring systems of a series of points) have a considerable effect on the appearance seen in the field of the microscope.

It is usually held that an object is in focus when the definition is sharpest. This, however, is not

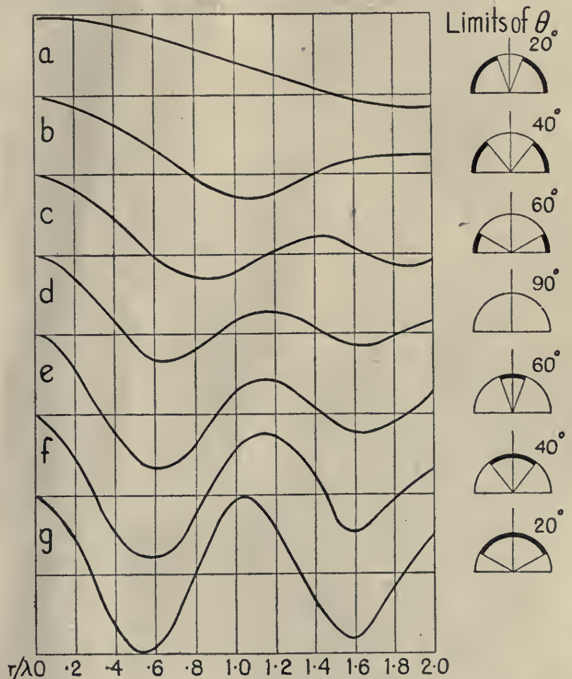

FIG. 3.—The curves are the algebraic integrals giving the areas included between the curves and verticals in Fig. 2 for each value of r/λ, and between the limits for θ indicated on each of the diagrams, namely:

Diagram	θ_1	θ_2			
a	20°	0	d	90°	0
b	40°	0	e	90°	20
c	60°	0	f	90°	40
			g	90°	60

The ordinates of the curves give the amplitudes of the resultant vibrations (expressed as fractions of the amplitude at the geometrical focus) at the various values of r/λ.

really the case. If bands of fine ruling in close proximity to one another are examined, it will be found that a separate adjustment of focus has to be made for each and that the best result is obtained when the focal adjustment makes the spacing of the lateral spectra the same as that of the lines of each band.

With ordinary test objects (diatoms, engraved lines, etc.) this effect is somewhat disguised owing to the thickness of the objects themselves, which is quite comparable to the wave-length, but in such test plates as I have described in my former letters, where the thickness of the film on which the lines are ruled is only 1/15 to 1/30 of a wave-length, the question of thickness does not arise.

The high resolving power which has been attained on diatoms and engraved lines should be attributed to variations of thickness in the objects, as these increase the rate at which the length of the optical path changes for points near the geometrical focus; *i.e.* for the variation of r. It is customary to mount such objects in media of high refractive index, which has the effect of exaggerating the optical depth of the grooves, etc., and it is worth notice that if an object has no thickness, or a thickness small compared to the wave-length and the only characteristic of which is a difference in opacity from place to place, the refractive index of the mounting medium is without effect on

the resolving power. In Fig. 4 let O and P be points in the focal plane. If the surrounding medium is air the optical length of the rays from O and P differ by $OP \sin\theta$. If O and P are covered by a uniform layer of a medium the refractive index of which is μ, the same rays in the medium make an angle θ' with the axis, where $\theta' \sin\theta' = \sin\theta/\mu$. The difference of optical length is then $OS\mu \sin\theta' = (OS\mu \sin\theta)/\mu = OS \sin\theta$, as it was in air.

This independence of μ does not extend to the case where one of the points O or P is slightly above or below the focal plane. If h is the elevation or depression in question, the difference of the optical lengths is $h(\mu \cos\theta' - \cos\theta)$, so that the difference increases both with μ and h. The quantity $0{\cdot}7\lambda$ suggested above as a limit to the resolving power of microscopes with respect to thin objects in the focal plane is a guess rather than an actual measurement. With the maximum angular aperture the radius of the first dark ring is a little greater than $0{\cdot}4\lambda$, which would indicate that objects must be separated by $0{\cdot}8\lambda$ before a really dark space appeared between their images; but the intensity of the light in the neighbourhood of the ring is very small, and doubtless the objects would seem as double at a less distance.

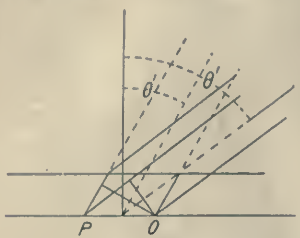

FIG. 4.

The experience, however, which I have had with fine lines ruled on thin films would induce me to place the limit at more, rather than less, than $0{\cdot}7\lambda$.

A. MALLOCK.

9 Baring Crescent, Exeter,
May 19.

The Fluorescence of certain Lower Plants.

IT will, I venture to believe, interest some of the readers of NATURE to know that the Cyanophyceæ (Schizophyceæ) or blue-green algæ, the diatoms and some at least of the true green algæ among, or closely related to, the Pleurococcaceæ, are visibly strongly fluorescent when viewed ultramicroscopically, if the proper optical conditions are achieved. A much wider claim for the usefulness of the method might be made, but it will be unnecessary; for the moment, if any one who may be interested tries it, he will appreciate at once its many possibilities.

The optimum conditions are these: a dark-field condenser, preferably of the cardioid type, *thin* glass object-slides (0·8 mm. thick or less), preferably thin covers and a *dry* objective of any magnification. Water between the upper lens of the condenser and the slide answers every purpose, and is much more comfortable in extensive ultramicroscopy. The best light source, when one is studying colour, and this becomes of prime importance in this connexion, is a small arc; but generally speaking, a condensed filament, 400-watt lamp with a suitable condenser, answers every purpose. The thin object-slide and the glass-air interface of the cover are the essential features, since one is then able to focus the *reflected* hollow beam of light from the upper surface of the cover glass upon the object. It will be seen that in using the dark-field condenser in this manner we are reviving the idea embodied in the "spot lens" of Thomas Ross, in Wenham's air paraboloid (1850) with a similar spot lens, and in his glass paraboloid condenser of 1856 (Siedentopf, H., "Die Vorgeschichte der Spiegelkondensoren," *Zeitschr. f. wiss. Mikroskopie*, 24: 382-395, 1907). As these could be used only with a dry objective, the later effort was aimed at the result achieved in our present apparatus. It is evident from current published directions of manufacturers for work with the dark-field illuminator that the use of the reflected light cone is not contemplated. I refer especially to the specifications as to object-slide thickness. While not having the advantage of the magnification afforded by the oil-immersion, we gain very greatly in many features of the object-picture afforded.

One of the most important of these is that the blue-green algæ, when seen at the apex of the light cone inverted by reflection, afford their fluorescence colours. Some species are more readily recognised to fluoresce than others, but if the material be mounted in strong glycerin, thus obviating the scattering of light by internal surfaces either in the organism or in the surrounding mucilage, the cells are then seen to glow with a fervid light, orange or crimson according to the organism. Indeed, when glycerin is used, the fluorescence can be seen without making use of the inverted light cone, just as, according to Siedentopf, bacteria lightly coloured with a fluorescent stain ("Über Beobachtungen bei Dunkelfeldbeleuchtung," *Zeitschr. f. wiss. Mikroskopie*, 25: 273-282) may be seen with oil-immersion objectives. The object-picture then afforded has advantages of its own which need not be detailed here. Without glycerin, the fluorescence, even of those species which are most readily observed in this respect, is scarcely visible with oil-immersion objectives.

When seen mounted in glycerin, then, some species of Oscillatoria are crimson, as also are Cylindrospermum, *Anabæna Azollæ*, some species of Nostoc and of Chroococcus, Rivularia, and others; while other species of Oscillatoria and Nostoc are golden orange. *Chroococcus refractus* (I do not assert positive identification) appears a dull yellow, all these forms affording a most striking contrast to their appearance by transmitted light, that with which students of them are familiar.

I have found evidence that the pigment is in solution in minute vesicles (supporting in part Wager's conclusions, Proc. R.S., 72: 401, 1903). With death, it becomes adsorbed by the cytoplasm and the cells then appear blue (*e.g.* Nostoc). On examining material of *Nostoc commune* from China, which I have had in my possession some twenty years, I found the cells as strongly fluorescent as if fresh. The stiff gelatinous sheath appears light blue, perhaps also from adsorbed phycocyanin. When freshly mounted in glycerin, blue-greens hold their fluorescence for some time. I have an Oscillatoria kept thus for twenty days without loss of fluorescence. The old *Nostoc commune* lost its fluorescence in less than twenty-four hours, perhaps because it was already dead.

I have shown that the fluorescence is due to phycocyanin, rather than to chlorophyll, which, because of the "colloidal condition" in which it occurs in the living cell, has not been found visibly fluorescent. E. Raehlmann ("Neue ultramikroskopische Untersuchungen über Eiweiss," etc., *Pflüger's Archiv ges. Physiologie*, 112: 128-171, 1906), it is true, thought that he could see chlorophyll fluorescence with the ultramicroscope, but he used suspensions or emulsions, and with these I have obtained similar results. With suitable means, the fluorescence microscope, for example, the fluorescence of the living chloroplast can be observed, but one can scarcely persuade oneself that it can be seen

with the ultramicroscope as ordinarily used. One can, I think, see a dim suggestion of the fluorescence colour in isolated chloroplasts (Elodea), and in the chloroplast of Spirogyra, but when *in situ* the multitude of reflecting surfaces produces so much transmitted light that the fluorescence is masked by the green coloration.

It was, therefore, of no small interest to find also that the pigment in the oil vacuoles of the diatoms, pale greenish-yellow by transmitted light, is also visibly deep red fluorescent when viewed in the manner above described. Glycerin must be used as a mounting medium. Examined thus, the fluorescent pigment is seen to fill vacuoles, large and small. I have found that this pigment is not destroyed at the temperature of boiling water, whereas phycocyanin changes at about 60° C. irreversibly, and loses its fluorescence. It may be the phycocyanin-like pigment found by Bocat (through Czapek, "Biochemie des Pflanzen," 1: 601) in Navicula, which, as a matter of fact, has two large fluorescent vacuoles and usually two small ones, one near each end of the cell.

Scenedesmus glows with a deep red light, as also a small species of Raphidium (or closely similar organism). I have found further evidence of fluorescence in other green forms, notably an ulvaceous one.

Many beautiful results will reward the microscopist who will use the method. Especially, one can scarcely contemplate the remarkable irradiance of these lowly plants without realising anew the importance of the problem of the physiological significance of fluorescence. In a paper presented at the recent meeting of the Royal Society of Canada, I have endeavoured to discuss the matter in its more general bearings. The immediate purpose is to direct attention to a means of increasing the usefulness of the dark-field condenser.

FRANCIS E. LLOYD.
McGill University, Montreal, June 1.

Dr. Kammerer's Lecture to the Linnean Society.

I AM very sorry to differ from my friend Prof. MacBride, but it is impossible for me to agree with some of his remarks on Dr. Kammerer's recent lecture (NATURE, June 23, p. 841). I did not assert that Dr. Kammerer made "childish mistakes which would disgrace a first-year student in biology." I expressed my opinion that it was not correct to state that the ovary of Salamandra is enclosed in a membrane while that of the bird is not. I fail to see why Dr. Kammerer's statement should require to be translated into modern technical language. It is a somewhat serious suggestion that he cannot express his ideas in such language for himself, and if that be so, it supports my criticism that in some respects his statements were not in accordance with the present state of biological knowledge.

I cannot, however, accept even Prof. MacBride's description of the condition of the ovary of the bird as correct (and I dissected out the ovary of a common hen to-day, not for the first time). The ovary of the bird is almost as completely invested by peritoneum as that of the Salamander, not only on its ventral surface but on its lateral surfaces also, and it is not largely retroperitoneal. I agree that the ovary of the bird is more difficult to remove in its entirety, because it is sessile on the peritoneum, and not connected with it by a membrane, and still more because its attachment is close to the great post-caval vein, so that it is difficult to remove the part by which it is attached without cutting into the vein. To be strictly correct, the narrow membrane which attaches the ovary to the wall of the body cavity in Salamandra is not a mesentery, as Prof. MacBride calls it, because that term means a membrane connected with the intestine.

It would serve no useful purpose to reply to other points in Prof. MacBride's letter. He refers me to Dr. Kammerer's "long paper." But I was dealing with the lecture as delivered and printed, which in my opinion failed to show that Dr. Kammerer had an adequate conception of the range of knowledge, the completeness of evidence, and the validity of reasoning, required to establish the conclusions he asks us to accept. I am not, of course, suggesting any deception on Dr. Kammerer's part—except self-deception. Lamarckian doctrine has often suffered more from the indiscretion of its advocates than from the attacks of its enemies.

J. T. CUNNINGHAM.
East London College, Mile End, E.1,
June 26.

The British Journal of Experimental Biology.

THOUGH British workers have made some of the most signal contributions to the morphological aspects of zoology, and names like those of Romanes, Bateson, Doncaster, and Geoffrey Smith will always be distinguished for pioneer discoveries in the experimental field, Great Britain at the present moment compares very unfavourably with other countries in facilities for the publication of researches in experimental biology, especially on the zoological side. There is no single journal devoted wholly or mainly to the subject, with the exception of the *Journal of Genetics*, which of course only covers a portion of the field. We have in Great Britain nothing to compare, for example, with the *Journal of Experimental Zoology*, the *Biological Bulletin*, and the *Journal of General Physiology* in America, or with the *Archiv für Entwicklungsmechanik* in Germany and the French *Archives de morphologie expérimentale*. Nor have we any biological journal which makes it a regular practice to publish articles of a general nature summarising and discussing critically recent additions to knowledge, as in the *American Naturalist* and the *Referaten* of several continental journals.

In the absence of an adequate medium of publication in Great Britain, experimental biologists do not know sufficiently what work is in progress, with the natural result that there is overlapping; that experimental inquiry, lacking a satisfactory channel of expression, may fail to exert an influence essential for the further development of biology in Great Britain; and that younger men will tend to migrate from the zoological laboratories to associate themselves with departments of human physiology. Biological science is at present passing through a period of transition: on one hand, it is becoming increasingly clear that the problems of evolution can no longer be dealt with adequately from the traditional morphological and descriptive point of view of zoology; on the other, the adoption of experimental methods by the general zoologist is opening up new fields of research and making it possible to study more readily the nature of many fundamental biological processes, such as fertilisation, development, sex and heredity, which have been too often neglected by traditional physiology. In the words of a distinguished morphologist, there is a growing tendency "to return to the practice of earlier days, when animal physiology was not yet divorced from morphology."

We believe that the time has now come when it is possible to issue a British journal devoted to general biology, in particular to experimental research and to

investigations bearing directly upon experimental problems. We have, therefore, arranged with Messrs. Oliver and Boyd, Edinburgh, to undertake the publication of the *British Journal of Experimental Biology*, the first number of which will appear in September next. The new journal will receive communications in comparative physiology, experimental embryology, genetics, and animal behaviour, as well as cytological, morphological, and histological contributions bearing on current experimental problems. It will also publish by invitation authoritative résumés of recent progress in various fields of inquiry. Any relevant original contribution will be considered for publication.

Inquiries may be addressed to the Animal Breeding Research Department, the University, Edinburgh.

F. A. E. CREW.
W. J. DAKIN.
J. HESLOP HARRISON.
LANCELOT T. HOGBEN.
J. JOHNSTONE.
F. H. A. MARSHALL.
GUY C. ROBSON.
A. M. CARR SAUNDERS.
J. MCLEAN THOMPSON.

An Einstein Paradox.

THE fallacy of the argument put forward by Prof. R. W. Genese, in the former part of his letter in NATURE of June 2, p. 742, lies in his supposing that the time t at which K sees the light-signal from L is related to the time t', when K_1 sees the same signal, by the transformation

$$t'=\beta(t-vx/c^2),$$

where $\beta=(1-v^2/c^2)^{-\frac{1}{2}}$.

If we suppose the light-signal to be emitted from L at a time T (in K's system) and T_1 (in K_1's system), then

$$T_1=\beta(T-vx/c^2), \quad . \quad . \quad . \quad . \quad (1)$$

$$x_1=\beta(x-vT), \quad . \quad . \quad . \quad . \quad (2)$$

where $x=KL$, $\quad x_1=K_1L$.

Suppose now that K receives the signal at time t (in his system) and that K_1 receives it at time t_1' (as judged by K_1's system). Let t_1 be the time in K's system corresponding to t_1' in K_1's system. Then

$$t=T+x/c, \quad . \quad . \quad . \quad . \quad (3)$$

$$t_1'=T_1+x_1/c, \quad . \quad . \quad . \quad . \quad (4)$$

and $t_1'=\beta(t_1-vx/c^2). \quad . \quad . \quad . \quad (5)$

Substitution from (1) and (2) in (4) gives, with (3),

$$t_1'=\beta t(1-v/c),$$

and comparison with (5) shows that $t \neq t_1$.

A little careful consideration of these equations will now show that the supposed paradox does not arise for the case $x_1=0$. J. T. COMBRIDGE.

King's College, Strand.

Multiple Temperature Incubator.

IN the course of some experimental work on insects which we have been carrying out, it was necessary to have a large number of constant temperatures. As it was impossible to have a complete incubator for every temperature, an incubator was designed by Mr. T. W. Kirkpatrick and myself to give a continuous series of constant temperatures.

The principle used is the conduction of heat along an insulated metal bar between two constant temperatures. In practice one of these is an ice-box and the other a hot water bath at any convenient temperature. Between the two is a bar, tube, or trough of metal, four to twelve feet long, which has holes bored at close intervals throughout its length. Both copper and aluminium have been used for the conducting bar. The whole is well insulated to avoid the influence of the daily temperature change.

The apparatus has exceeded our expectations and would probably be of great use to investigators in other fields. Full details with scale drawings and temperature charts will be published shortly in a Bulletin of the Ministry of Agriculture of Egypt, which will be sent to any one who is interested.

C. B. WILLIAMS.

Ministry of Agriculture (Entomological Section), Cairo, June 20.

Phosphorescence caused by Active Nitrogen.

IN order to prepare aluminium chloride for atomic weight determination, I burnt pure aluminium metal in a current of pure dry chlorine. Before starting the reaction, pure dry nitrogen was passed through the apparatus to expel the air. After this has been attained, the flow of nitrogen was stopped and a slow current of pure dry chlorine was allowed to pass over the metal. Since the pure dry gas reacts very slowly with aluminium at ordinary room temperature, the tube containing aluminium was heated to about 500° C. After the completion of the reaction, the aluminium chloride formed and a quantity of uncombined metal was cooled in a very slow stream of nitrogen. As the red heat ceased, a bright green phosphorescence appeared in the reaction tube surrounding small pieces of corroded uncombined metal.

This phenomenon was excited the next day when the synthesis was continued, and the last traces of chlorine were removed by nitrogen. In both cases the afterglow disappeared after about one minute. Two important facts should be added, namely:

(1) The reaction tube—free of chlorine—with aluminium chloride and the metal was heated again to the same high temperature, and nitrogen was passed over while the whole system was cooling down. The bright green light did not appear. Nothing of this kind of light was visible when the pure metal was heated alone. This is a sufficient proof that the observed afterglow in the former cases was not caused by a trace of any known or unknown impurity of the metal used.

(2) The phenomenon was not observed during the synthesis of aluminium bromide which was carried out by Prof. Th. W. Richards and me in the same manner, and with an aluminium of the same origin.

In NATURE of May 5, p. 599, and May 26, p. 705, were published letters by Prof. E. P. Lewis and Mr. W. Jevons describing phosphorescence caused by active nitrogen. These letters, particularly the second, by Mr. W. Jevons, suggested to me that the afterglow of aluminium left in the reaction tube was very probably caused by active nitrogen. The presence of traces of active nitrogen was caused by the violent reaction of the chlorine left in the tube with the aluminium metal. This reaction activated some of the nitrogen passed over the metal. When, however, all the chlorine was expelled and the contents of the reaction tube were heated as in the case described above, no phosphorescence appeared. H. KREPELKA.

Department of Inorganic Chemistry, Charles' University, Prague, Czechoslovakia.

The Cryogenic Laboratory of the University of Toronto.

By Prof. J. C. McLennan, F.R.S.

SHORTLY after the commencement of the War it became evident that if helium were available in sufficient quantities to replace hydrogen in naval and military airships, losses in life and equipment might be very greatly lessened.

It was known that there existed in America supplies of natural gas containing helium in varying amounts, and Sir Richard Threlfall, as a result of preliminary calculations that led him to believe that this helium could be extracted at a cost that would not be prohibitive, proposed that the Board of Invention and Research of the British Admiralty should undertake an investigation of the matter. As a result of this proposal the writer was asked by the Board to determine the helium content of the natural gases of Canada. This survey was carried out in the winter of 1915–16, and it was found that from 10,000,000 to 12,000,000 cubic feet of helium could be obtained per year from the natural gas of the Bow Island supply near Calgary, Alberta.

In the autumn of 1917 the Admiralty sanctioned proposals to proceed with an attempt to extract this helium, and in the summer of 1918, after exhaustive experiments had been made, a plant was designed for the purpose. This apparatus was constructed and installed at Calgary and was operated from September 1919 until April 1920. In the course of this operation of the plant, considerable supplies of helium of high purity were obtained and it was shown that the estimates of Sir Richard Threlfall as to the cost of production were amply verified.[1]

During the winter of 1919–20 proposals were put forward by the writer to use the helium extracted at Calgary for scientific purposes. These met with approval, and financial grants were made for the liquefaction of helium by the Honorary Advisory Council for Scientific and Industrial Research of Canada, by the University of Toronto, and by the Carnegie Foundation for Research. Some apparatus was also loaned by the Admiralty and by the Air Ministry of Great Britain. With these grants special apparatus for liquefying air, hydrogen, and helium was constructed and its installation in the Physical Laboratory of the University of Toronto was completed towards the end of 1922. In the preliminary operation of the plant, special facilities in the way of power were provided by the Hydro-Electric Commission of Ontario and by the Hydro-Electric Commission of Toronto.

[1] Trans. of the Chem. Soc. vol. 117, p. 923, 1920.

Helium was liquefied with the equipment for the first time on January 10 of this year, and the Cryogenic Division of the Physical Laboratory was formally opened on January 24, when demonstrations were given of the production of liquid air, liquid hydrogen, and liquid helium. Series of experiments were also shown illustrating the uses of these liquefied gases.

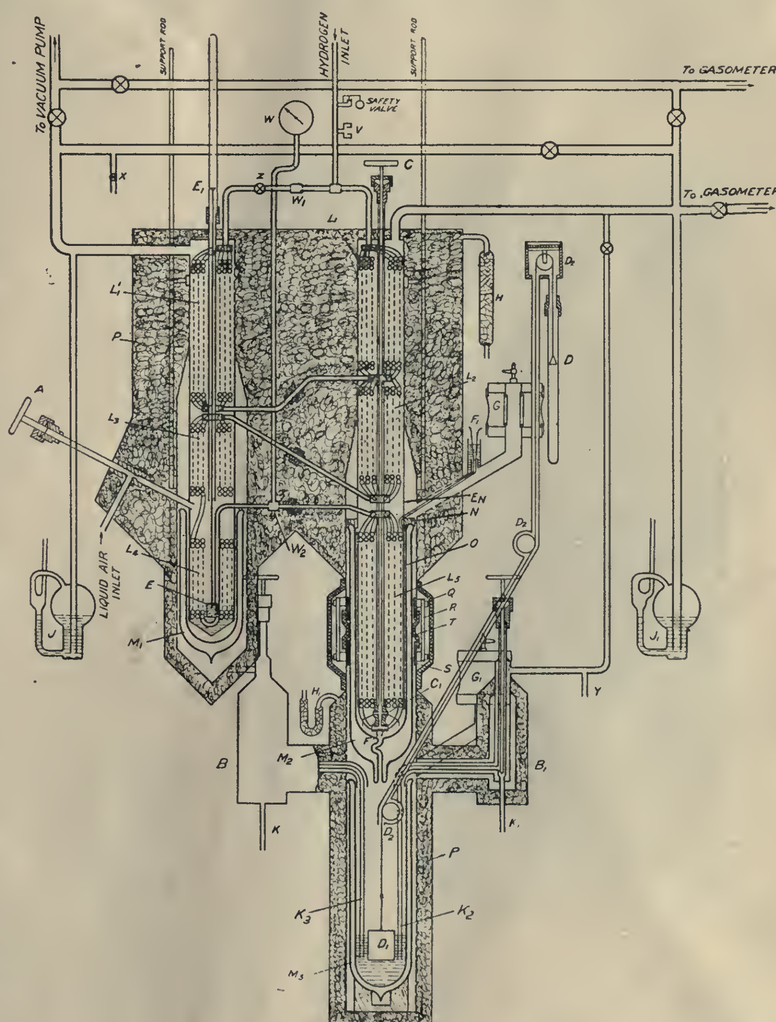

FIG. 1.—Hydrogen liquefier.

Liquid Air Apparatus.

The apparatus constructed for the liquefaction of air consisted of a 40-kilowatt alternating current motor, a Norwalk compressor of the three-stage type, a water cooler, carbon dioxide purifying towers, and one of L'Air Liquide's machines having a capacity of producing 20 cubic metres of oxygen per hour. This machine was provided with valves which enabled one to isolate the rectification column from the oxygen heat exchanger, permitting the operation of the apparatus as a machine for liquefying air or as one for producing gaseous oxygen. The column was also

provided with modifications for the extraction of the rare gases from the atmosphere. In operating this apparatus the air was compressed to 40 atmospheres, and in a series of tests it was found that about 300 kilograms of liquid air could be made per day. With such a supply of liquid air available, ample provision was made, it will be seen, for meeting the needs in regard to liquid air of all departments of the University.

Liquid Hydrogen Apparatus.

The equipment for liquefying hydrogen included a four-stage belt-driven compressor built by the Burckhardt Engineering Works of Basle, Switzerland. Its cylinders were water-cooled, had a forced lubrication,

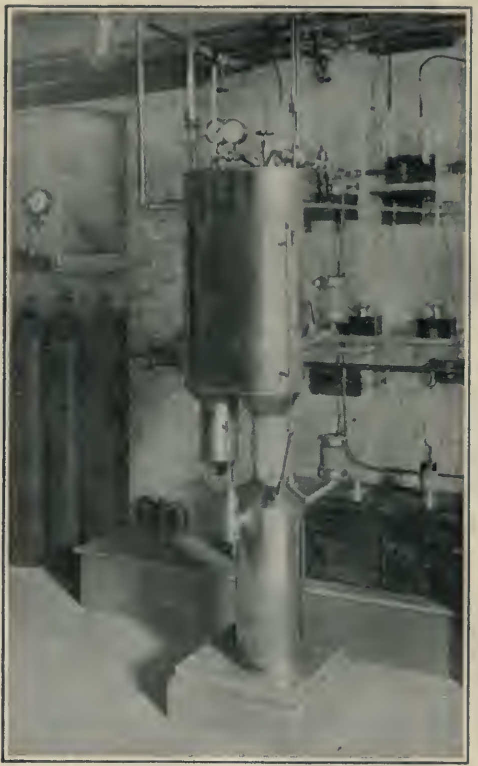

Fig. 2.—Hydrogen liquefier (as installed).

and were fitted with steel piston rings. The pistons were all in line and constituted one shaft. The gas was cooled after each compression by means of a number of heat exchangers immersed in a tank of running water. The compressor was constructed so as to prevent any loss of gas, and with this end in view, the piston rods were provided with special stuffing boxes in which the packing was sealed with oil contained in specially designed holders.

The space behind each piston as well as the safety valves was directly connected with a gasometer and through the latter to the intake of the compressor. The compressor had a capacity of 60 cubic metres of free gas per hour and required a motor of 30 kilowatts to operate it when delivering at 200 atmospheres pressure. Twenty litres of water per minute were disposed of by the heat exchangers.

The hydrogen liquefier is shown schematically in Fig. 1 and as it was installed in the laboratory by Fig. 2. The regenerator coils indicated were similar to those used in the well-known Hampson apparatus for liquefying air. In operating the liquefier, hydrogen specially purified was compressed to 150-200 atmospheres and cooled to −205° C. by means of liquid air boiling under reduced pressure.

The compressed hydrogen passed successively through the coils L_1, L_1', L_2, L_3, L_4, and L_5. The coils L_1 and L_1' were arranged in parallel and the valve Z served to regulate the proportion of gas that went through each of them. This ensured the proper interchange of heat between the oncoming compressed gas and the outgoing low-pressure vapours. The coils L_1, L_2, and L_5 were cooled by gaseous hydrogen returning to the gasometer from the expansion nozzle C_1, and the coils L_1' and L_3 by the evaporated air drawn off by the vacuum pump. The coil L_4 was partly immersed in a bath of liquid air held in the flask M_1.

The valve A served to admit more liquid air from the reserve supply whenever the indicator E_1 of the cork float E showed that it was required. To add to the efficiency of the liquefier, the expansion coil L_5 was provided with a close-fitting German silver envelope which when properly wrapped with flannel permitted a good junction to be effected between the inner wall of the silvered vacuum flask M_2 and the coil. This ensured that the expanded gas passed over the closely wound tubes of the coil and so brought about a good exchange of heat.

The liquid hydrogen as it formed passed through the opening in the bottom of the flask M_2 and was collected in the silvered flask M_3. The float indicator D, D_1, D_2, served to show the level of the liquid in this collecting flask. The weight D was connected with the thin German-silver float D_1 by means of a silk thread running over three pulleys D_2 provided with jewel mountings. The valves B and B_1 were used for drawing off the liquid. These were arranged so that they could be pre-cooled by cold gaseous hydrogen as it was returned to the gasometer. The stuffing boxes and screw thread of the valves B, B_1, C and A were so arranged that they were not exposed to cooling and in this way the danger of a freeze-up was eliminated.

The insulation of the apparatus was specially studied. Vacuum flasks were used where possible, and wherever parts were cooled below the temperature of liquid air they were surrounded by an atmosphere of dry hydrogen or by a partial vacuum in order to avoid unnecessary condensation. All parts were constructed of German silver where it was an advantage to do so on account of its low thermal conductivity. The entire apparatus was packed in natural wool and enclosed in a thin brass case that was sealed except for the drying tubes H and H_1. These tubes served to equalise the internal and external pressures on the case and at the same time prevented water vapour from entering and condensing inside. Fig. 1 shows plainly the arrangement for supporting the apparatus together with the scheme of the pipe connexions. Mercury traps J and J_1 served to protect the apparatus at all times from any sudden but moderate excess of pressure, while the large rubber safety valves G and G_1 served to accommodate any sudden but violent

increase of pressure such as might arise from the breaking of the flask M_3.

In operating with the hydrogen liquefier it was found necessary to remove all gaseous impurities from the gas. The commercial hydrogen used was made electrolytically and was found to contain as much as 1·5 per cent. of oxygen and 0·1-0·3 per cent. of nitrogen. To purify this gas it was passed through a high pressure bomb filled with palladiumised asbestos. This bomb was heated electrically to about 400° C., and at this temperature the palladium acted as a strong and robust catalyser. The water produced by the union of hydrogen with the oxygen present was taken up with caustic potash. The hydrogen obtained after this preliminary purification was again purified by passing it through a specially constructed apparatus provided with coils cooled with liquid hydrogen, but to make the liquid hydrogen for carrying out this purification it was necessary to operate the hydrogen liquefier with the hydrogen subjected to the preliminary purification only. A few litres only could be made in a run before stoppage occurred, and this was used to effect the final purification of a certain quantity of the gas.

By repeated operations of this character a supply of about 100 cubic metres of highly purified hydrogen was gradually accumulated, and with it long runs of the liquefier were made without any stoppage occurring. To conserve this original supply of pure hydrogen care had to be taken during a run to store up all gas from the vaporised hydrogen and to use residual supplies of liquid hydrogen to purify additional quantities of the gas so as to make up losses.

In liquefying hydrogen as well as helium, it was necessary in order to avoid losses so far as possible to operate in a closed cycle that included a gasometer, the compressor and the liquefier. In a number of actual runs with the apparatus described above, no difficulty was experienced in making from 10 to 15 litres of liquid hydrogen an hour, and in one particular run as much as 50 litres of liquid hydrogen was accumulated.

LIQUID HELIUM APPARATUS.

The helium used in the experiments was obtained from the natural gas of the Bow Island district near Calgary, Alberta, in the year 1919–20, and had been kept since then safely stored in steel cylinders at about 150 atmospheres pressure. An analysis by means of absorption with cocoanut charcoal showed the gas in different cylinders to be about 90-95 per cent. helium. The chief impurity was nitrogen, with a varying percentage of methane and other gases. Tests made by chemical absorption and explosion methods gave no indication of hydrogen being present.

The preliminary purification of the helium was effected by cooling it at a pressure of 150 atmospheres to −205° C. by means of liquid air boiling under reduced pressure. Under these conditions a large percentage of the impurity was condensed and drawn off. This partially purified helium was passed at high pressure first through a bomb filled with copper oxide and palladiumised asbestos maintained at a temperature of 400° C., and then through heavy copper tubes filled with cocoanut charcoal and immersed in liquid air. This cycle of purification proved to be satisfactory, for during the liquefaction process there was no evidence at any time of any blocking of the expansion valve of the liquefier or of the very small capillary tubes that made up the expansion coil.

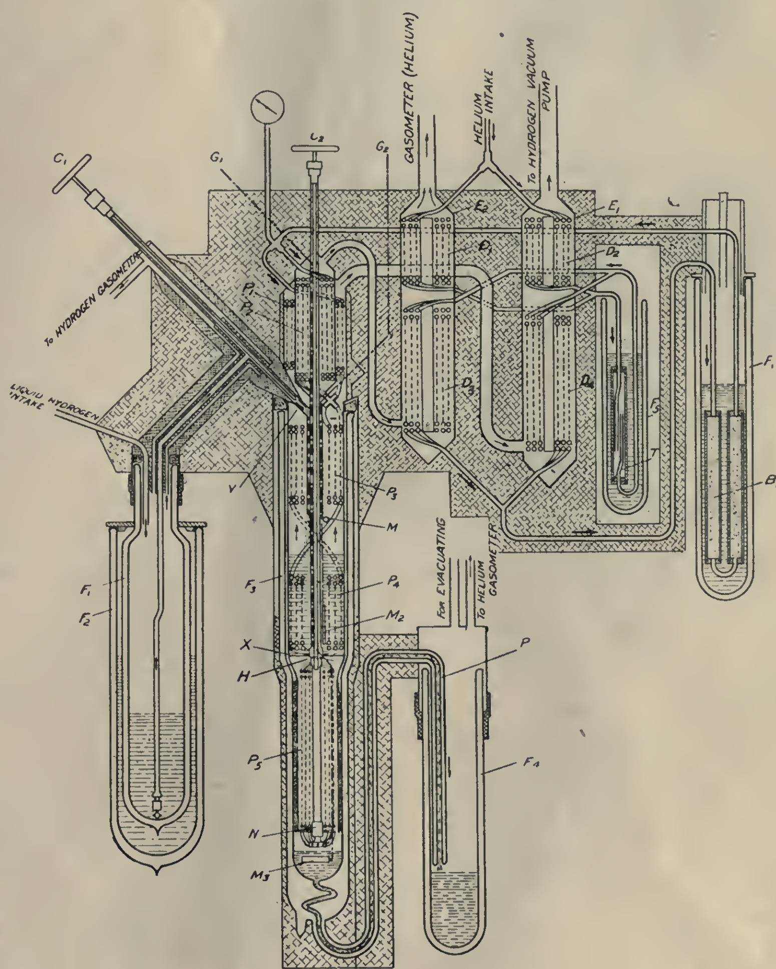

FIG. 3.—Helium liquefier.

In the design and construction of the helium liquefier, special attention was given to problems connected with the heat capacity and heat insulation of the various parts of the apparatus. The liquefier is shown diagrammatically in Fig. 3 and the manner in which it was installed in the laboratory is shown in Fig. 4.

In the operation of the liquefier the manner in which the helium entered the apparatus is shown in the

diagram. It passed successively through the coils D_1, D_2 and D_3, D_4 arranged in parallel. It then entered

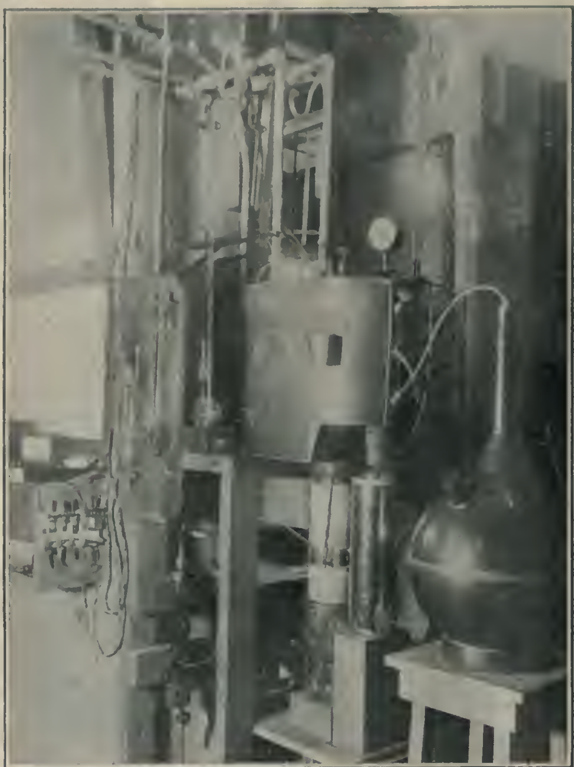

Fig. 4.—Helium liquefier (as installed).

the coils P_1 and P_2 also in parallel, and afterwards passed successively through the coils P_3, P_4 and P_5. The coils D_2, D_4, P_1 and P_3 were cooled by the cold hydrogen vapour as it was drawn off by the hydrogen vacuum pump, and the coils D_1, D_3, P_2 and P_3 by the expanded helium that issued from the region about the expansion valve on the way to the gasometer. The coil P_4 served for the final pre-cooling of the compressed helium and was immersed in liquid hydrogen boiling under a pressure of 6 cm. of mercury. A trap T was provided, by means of which the gas was freed from the last traces of oil or water vapour from the compressor. The tubes B_1 were made of copper and were filled with cocoanut charcoal. They were cooled with liquid air during the liquefaction process with a view of absorbing any gaseous contamination introduced during the operation of the cycle. The level of the liquid hydrogen in the refrigerator surrounding the coil P_4 was determined by means of copper-constantan thermo-couples, and alternatively by helium gas thermometers with reservoirs at M and M_2, that were connected with a mercury manometer by fine steel tubing G_2.

The liquid hydrogen from large vacuum-surrounded metal containers was first transferred to the unsilvered flask F_1, that was protected by an outer silvered flask F_2 containing liquid air. This flask F_2 was provided with two unsilvered vertical observation strips, one on either side, so that the level of the liquid hydrogen in F_1 could be seen directly. The valve C_1 controlled the intake of the liquid hydrogen from F_1 to the refrigerator, and the valve C_2 with its corresponding spindle controlled the expansion nozzle at the bottom of the coil P_5. The efficiency of the regeneration properties of the expansion coil P_5 was assured by fitting closely over it a very thin german-silver envelope soldered at X to the bottom of the german-silver liquid hydrogen container. With this arrangement the expanded helium was forced to go through the interstices of the expansion coil in order to enter the holes H in the tube surrounding the expansion valve spindle.

The temperature of the region beneath the expansion nozzle was determined with a helium gas thermometer provided with a german-silver reservoir at M_3 and a connecting steel capillary tube G_1. The protecting vacuum flask F_3 was provided with a specially designed siphon tube P. This tube was double-walled and was protected by silvering and by an intervening vacuum in the same manner as a Dewar flask. The flask F_4 could be made either totally silvered or partially silvered with a plain portion at the bottom. In the latter case it was protected by a plain vacuum flask containing liquid hydrogen, and this in turn by a plain vacuum flask containing liquid air.

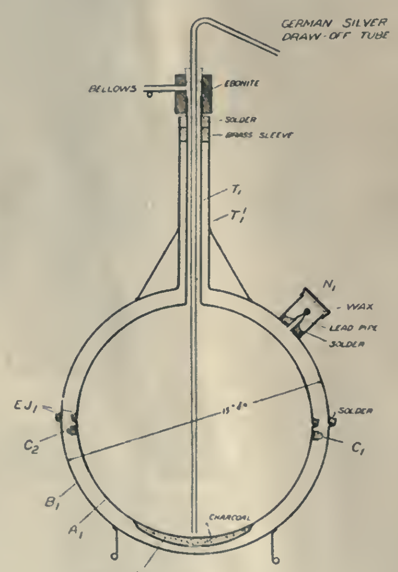

FIG. 5.—Metal container for liquid air.

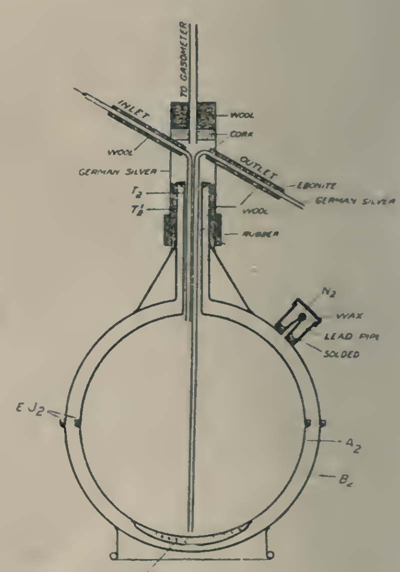

FIG. 6.—Metal container for liquid hydrogen.

These figures illustrate the types of metallic vacuum Dewar Flasks found useful in handling large quantities of liquid air and liquid hydrogen. They were made of polished spun copper. In assembling them, extreme precautions, it was found, had to be taken to remove not only the air but also all water vapour from the space between the spherical surfaces. A container of 25 litres capacity when well constructed did not lose so much as a kilogram of liquid air per day.

In constructing the hydrogen and helium liquefiers great care was taken to see that all the complicated

tubing was free from holes and much time was consumed in the work of eliminating leaks. The whole apparatus was, however, completed towards the end of 1922 and, as stated, was used early in January of this year for the production of liquid helium. The helium was compressed with an enclosed Whitehead torpedo compressor, and the liquefier was found to give the best results when run at a pressure of only 40 atmospheres.

Before attempting to make liquid helium all parts of the liquefier were cooled as low as possible with liquid air, the piping being cooled by circulating through it helium that had been previously cooled to liquid air temperature. When this precaution was taken, it was found that liquid helium could readily be made with a moderate amount of liquid hydrogen supplied to the refrigerator surrounding the coil P_4. In our experiments less than 10 litres of liquid hydrogen sufficed to produce more than a litre of liquid helium.

I wish to take this opportunity of acknowledging my indebtedness to Prof. Kamerlingh Onnes of Leyden, the pioneer and outstanding authority in research at liquid helium temperatures. He not only assisted me very materially through correspondence and conversation, but also furnished me with drawings of the installation at Leyden.

It is hoped that with the cryogenic equipment now available at the University of Toronto, a series of low-temperature researches will be organised shortly for workers who for any reason may not find it convenient to go to Leyden to carry out investigations.

Rickets in Vienna.

A NUMBER of summary publications have made readily available the rapid advance in our knowledge of rickets in the last few years since Mellanby in 1918 brought forward serious evidence implicating a deficiency of fat-soluble vitamin A, and Huldschnisky in 1919 showed that the bone-lesions in children could be cured by ultra-violet light, and McCollum and his co-workers in 1921 demonstrated that the disease could be conveniently produced in rats by defective diets. Last year the Medical Research Council published the survey by Prof. Korenchevsky [1] of the experimental aspects and Dr. J. L. Dick [2] brought out a useful book on the human disease and its history. More recently an admirable survey of the whole question by Prof. E. A. Park [3] has appeared, and there has now been added a full account of the results of the expedition under Dr. Harriette Chick,[4] sent in 1919 to Vienna by the Lister Institute and the Medical Research Council, to study deficiency diseases under the conditions of almost experimental accuracy and precision afforded by the generous hospitality of Prof. v. Pirquet's Kinderklinik.

The report shows, beyond any reasonable doubt, that the incidence of rickets may be determined by diet, and that vitamin A plays an important part; that it may be prevented and cured by cod-liver oil; that it may be cured by sunshine or the rays from a mercury-vapour lamp, and that a diet which in summer is adequate for young infants may, in winter gloom, permit its development. From the practical point of view, the facts provide most of what the sanitarian needs: a proper supply of cod-liver oil, or its equivalent in vitamin A, and of sunshine, or its equivalent in ultra-violet light, will prevent rickets, and a deficiency of one may be made good by a larger supply of the other. What is at present unknown is how much vitamin A in the more customary forms of milk and green vegetables is wanted to give the same result as teaspoonfuls of the far more potent cod-liver oil. But there is no longer any excuse for there being two schools of thought disputing for a hygienic and a dietetic ætiology respectively: as usually happens in such controversies, it turns out that both parties are right.

In the larger matter of the circumstances which condition the proper and regular growth of bone the results are of great interest. Granting an adequate supply of the necessary materials—and of these calcium and phosphorus are the most obvious, and their importance has already been examined by direct experiment—vitamin A is necessary: with enough of this, rats grow satisfactorily in the dark (Goldblatt and Soames, *Biochemical Journal*, vol. xvii., 1923, p. 294). Ultra-violet light of about 300 $\mu\mu$ has much the same effect, and it was at first supposed, rather naturally, that it operated by causing a photo-synthesis of vitamin A. But rats on a diet grossly deficient in vitamin will grow normally under the influence of ultra-violet light only for a time: in the end, if no vitamin A is provided in the food, growth ceases, and the animals go downhill. Evidently light enables the animal to make the most economical use of such store of vitamin as it may have in its body or of any small amounts it may receive in its food: light can only partly replace vitamin, and if there is abundance of vitamin, light has no favourable influence on growth. In the same way vitamin makes a short supply of calcium or phosphorus go further, so that, while any of the three may be a limiting factor, up to a certain point of deficiency it is the sum (or product) of calcium phosphate and vitamin which is the effective determinant. Light *per se* is not a limiting factor, but may become the determinant under conditions of defect in the others.

Obvious as is the effect of ultra-violet light on the naked human skin, it is a little difficult to believe that it can act directly on the general body surface of hairy animals such as rats: "man is naked," as Richard Owen remarks, "and is the only terrestrial mammal in that predicament." It is, therefore, satisfactory to find it shown that air irradiated by the mercury vapour lamp is effective in promoting growth in rats, as Kestner showed it was in hastening the regeneration of blood lost by hæmorrhage: such air, in the absence of ultra-violet light itself, will also cure rickets in children. It does not seem to be known as yet whether radiation of the body surface with exclusion of radiated air

[1] Medical Research Council Special Report Series, No. 71. The Aetiology and Pathology of Rickets from an experimental point of view. Pp. 172+18 plates. (London: H.M Stationery Office, 1922.) 4s. net.
[2] London: W. Heinemann.
[3] *Physiological Review*, vol. iii., 1923, p. 106.
[4] Medical Research Council Special Report Series, No. 77. Studies of Rickets in Vienna 1919–22 (Report to the Accessory Food Factors Committee appointed jointly by the Medical Research Council and the Lister Institute). Pp. 203+14 plates. (London: H.M. Stationery Office, 1923.) 7s. 6d. net.

from the lungs has any influence on bone-growth, nor on what constituent of the radiated air the effect depends.

It is possible that the mechanism in man is not quite the same as in hairy animals, and that direct irritation of the skin by sunshine—to which some clinical observers attach considerable importance—does much the same as irritation of the bronchial mucous membrane, which is embryologically the same as skin, by ionised air or traces of ozone or nitric oxide. If this is so, irritation of the skin by means other than ultra-violet light should have the same effect—which is perhaps the explanation of Dr. Mayo's observation on rickets in 1674 that "scabies or itching contributes much to its cure." Little is known about what has been called the "internal secretion" of the skin beyond the fact that irritation may lead to changes in other parts of the body. Thus a blistering agent applied locally may considerably increase the susceptibility of the whole skin to the same substance.

Current Topics and Events.

In an article which appeared in Nature of July 21, p. 101, the view was expressed that the constitution of the committee of the recently formed British Empire Cancer Campaign was not such as would command the respect of *bona fide* workers on the cancer problem. While our article was in type, a meeting of the Grand Council of the British Empire Cancer Campaign was held, and contrary to the original intention, and no doubt as a result of informed public opinion, it was decided to appoint a scientific advisory committee of ten members. It was urged, however, that an attempt should still be made to preserve the balance between scientific and clinical workers. On the following day the annual meeting of the Imperial Cancer Research Fund was held under the presidency of the Duke of Bedford, who expressed himself as in entire agreement with the attitude which had been adopted by the executive committee of the Fund in resisting the danger of being drawn into the British Empire Cancer maelstrom. In an admirable review of the work of the campaign he directed attention to the crass ignorance which prevails with respect to the work which has been done by the Fund, and he laid great stress on the necessity for the British Empire Cancer Campaign to be in the hands of those acquainted with work already done, as this is the only means of avoiding useless repetition and preventing the waste of funds obtained from a generous and sympathetic public.

Congratulations are due this week to the Rev. Dr. T. G. Bonney, who celebrated his ninetieth birthday on Friday, July 27, having been born at Rugeley, Staffordshire, in 1833. The son of a clergyman, Dr. Bonney was the eldest of ten children. Educated at Uppingham, he was sent to St. John's College, Cambridge, where he graduated twelfth wrangler, and soon after accepted a post as mathematical master at Westminster School. It has been said of him as regards his early education, that "mathematics had impressed upon his mind the real necessities which are demanded by a proof; classics had assisted him to cultivate a literary gift; and travel had taught him facts at first hand." Ordained a priest in 1858, in the following year he was elected to a fellowship at St. John's. In 1877 Dr. Bonney took up the professorship of geology in University College, London, a post he held until 1901. For four years secretary of the British Association, he was president of the Geological Society, 1884–86, and president of the British Association at the Sheffield meeting of 1910, giving an address on some aspects of the glacial history of Western Europe. In 1889 he was awarded the Wollaston gold medal of the Geological Society. In allotting the gift the then president remarked that in Dr. Bonney's hands the microscope had been a valuable adjunct to field-observation and had been chiefly applied to detect the secrets of those rocks which, possessing no organic remains to betray the tale of their origin, had hitherto baffled inquiry into their early history.

On June 16 the Polish Academy of Sciences and Letters at Cracow celebrated, in the presence of the President of the Polish Republic, the fiftieth anniversary of its foundation. The Academy originated in 1873, evolving from a scientific society which has existed in Cracow since the beginning of the nineteenth century. The first president of the Academy was Józef Majer, a man who rendered valuable service to the cause of science in Poland; he was succeeded by Count Stanislas Tarnowski, for many years professor of the history of Polish literature in the Jagellonian University; Prof. Casimir Mozawski, a philologist of European renown, is now president. The Academy is divided into three classes—devoted respectively to philology and linguistics, to historical and social science, and to mathematical, physical, and natural science. In conformity with the statutes, the Academy consists of 60 active Polish members, 36 foreign and 96 corresponding members. The publications of the Academy since 1873 are numerous; they include 206 volumes of the Transactions of the Classes, 50 volumes of the Proceedings (the Cracow *Bulletin International* is well known to scientific men all over the world), 10 volumes of a beautiful publication intended to promote the cultivation of the history of art in Poland, 146 volumes of transactions of various committees appointed to elucidate problems in the history of Polish language, literature, and civilisation, 90 volumes of publications on Polish political and economical history, 57 volumes of the Transactions of a special committee investigating the physiography of Poland (meteorology, geophysics, mineralogy, and geology, systematic botany and zoology), 36 volumes of the Transactions of the Anthropological Committee, 10 volumes of the "Polish Encyclopædia" (in course of publication), and more than 300 volumes of various other works separately published. The Academy possesses a fine

library (with many valuable MSS.), remarkably rich physiographical and anthropological collections, a permanent scientific station at Paris (4 Quai d'Orleans), and a quasi-permanent station (chiefly for historical investigation) at Rome.

DR. A. E. H. TUTTON is to be congratulated on the completion of a laborious piece of work which he set himself in 1890. This was the investigation of the isomorphous relations existing between the sulphates and selenates of the alkali metals and ammonium and the double salts of these with certain divalent metals. It is noteworthy that this work has been performed in his spare time, and for the last twelve years in Devonshire. In his presidential address to the Devonshire Association at Salcombe on July 10, he gave a general review of the results attained and of their bearing on the structure of crystals and of atoms. In all, seventy-five salts have been worked out in the greatest possible detail and their crystallographic and other constants determined with the highest degree of accuracy, for which purpose several elaborate instruments were specially designed. In eighteen groups, in which potassium, rubidium, and cæsium are the replacing elements, it is repeatedly and conclusively proved that the constants vary with the atomic weights of these elements, and consequently also with their atomic number and atomic diameters. The dimensions deduced for the structural units of these crystals have since been amply confirmed by the X-ray analysis of crystal-structure. But the more direct and very carefully made observations will be of permanent value for testing theories of the future.

AT a meeting of the Board of Directors of the Manchester Chamber of Commerce held on July 16, the following resolutions were passed unanimously: That, whereas the word "gallon" is at present capable of different interpretations (due to the difference of about 20 per cent. between the Imperial and the American gallon), and whereas the alternative use of the litre is already sanctioned by law throughout the commercial world, it is desirable that all traders—especially those concerned in overseas trade—should promote uniformity of trading practice by employing the litre as the sole unit of capacity. (*N.B.* If those engaged in any special trade desire to retain the word gallon it should be in the form of a "new gallon" equal to 4 litres, which would approximately represent the average value of the present conflicting gallons.) That, whereas the word "ton" is at present capable of different interpretations according to whether the "long," "short," or "metric" ton is intended, and whereas the use of cwts., quarters, stones, and other local weights involves further confusion and loss of commercial efficiency, it is desirable that all traders—especially those concerned in overseas trade—should express the weights of goods in pounds only, and convert such pounds when desirable into equivalent weights in kilograms.

OWING to the work of redecorating the rooms of the Chemical Society, the library will be closed during the entire month of August, and in accordance with the usual practice will close at 5 P.M. daily on September 1-17.

THE following have been elected honorary members of the Society of Chemical Industry: Prof. C. F. Chandler, United States; Prince Ginori Conti, president of the Italian Chemical Society; M. Paul Kestner, president of the French Society of Chemical Industry; Prof. Joji Sakurai, Japan; and Sir Dorabji J. Tata, India.

THE annual autumn meeting of the Institute of Metals will be held in Manchester, on September 10-13. The meeting will open with the second annual autumn lecture, to be delivered by Sir Henry Fowler, on "The Use of Non-ferrous Metals in Engineering." Papers will be read and discussed on the mornings of September 11 and 12, and visits to works and places of interest in the neighbourhood have been arranged.

APPLICATIONS for Yarrow Research Professorships will be received by the Secretaries of the Royal Society until October 1 next, as the president and council of the society will in the autumn consider the appointment of one, or possibly more, professors who will be expected to devote their whole time to research in the mathematical, physical, chemical, or engineering sciences. Further particulars are obtainable from the Assistant Secretary of the Royal Society, Burlington House, Piccadilly, W.1.

AT the annual general meeting of the Royal Veterinary College held on July 17 the Duke of Connaught, president of the College, announced that, in conformity with the recommendation recently made by the advisory committee on Research in Animal Diseases, the Development Commission, through the Ministry of Agriculture, has made a grant of 25,000*l.* for the erection of a new research institute in connexion with the College. It is hoped that the new premises will be ready for occupation in less than a year.

AT the recent meeting of the trustees of the Beit Memorial Fellowships for Medical Research, the honorary secretary, Sir James Fowler, presented a review of the work of the trust for the period 1910–1923. Since the foundation of the trust in 1909, seventy-nine fellowships have been awarded. Originally the annual value of the fellowships was 250*l.*; this was increased to 300*l.* in 1919 and to 400*l.* in 1920. In 1922 they were reclassified as junior, fourth-year, and senior, with the values, 350*l.*, 400*l.* and 600*l.* respectively. Of the first fifty fellows elected, two have been made fellows of the Royal Society, eight have secured professorships, four have become directors of research institutes, and most of the remainder are holding responsible appointments.

THE Ramsay Memorial Fellowship Trustees have made the following elections to fellowships and renewals of fellowships for the Session 1923–24, the place of research where stated being given after the

name of the fellow elected: *British Fellowships* (300*l*.): Dr. S. Coffey, at University College, London; Dr. A. F. Titley; and Dr. R. W. Lunt, at University College, London. *Glasgow Fellowships* (300*l*.): Mr. T. S. Stevens and Mr. J. A. Mair, both at the University of Glasgow. *Norwegian Fellowship* (5400 kroner): Mr. G. Weidemann, at the Biological Laboratory, University of Cambridge. *French Fellowship* (100*l*. plus 14,000 francs): Dr. H. Weiss, at the Royal Institution (Davy-Faraday Laboratory). *Netherlands Fellowship* (300*l*.): Mr. J. Kalff. *Danish Fellowship* (300*l*.): Mr. K. Højendahl, at the University of Liverpool. Since the institution of the Ramsay Memorial Fellowship Trust in 1919 twenty-one fellowships, not including those announced above, have been awarded.

THE thirty-fourth congress of the Royal Sanitary Institute will be held at Hull on July 30-August 4 under the presidency of the Right Hon. T. R. Ferens. The proceedings will be divided among four sections dealing with sanitary science, engineering, and architecture, maternity and child welfare, and personal and domestic hygiene respectively. In addition to the sectional meetings a number of conferences of representatives of sanitary authorities, medical officers of health and similar workers have been arranged. Sir Alexander Houston will lecture to the Congress on "A Pure Water Supply," and among the subjects to be discussed at the various meetings are the prevention of tuberculosis and cancer, the curative value of ultra-violet rays, the nutritive value of milk, heliotherapy, the smoke evil, and food-poisoning. Several Government departments and also foreign and Dominion Governments are sending delegates. Visits will be paid to local institutions, water-works, and factories, and a Health Exhibition showing apparatus and appliances relating to health and domestic use will be open throughout the meeting.

THE 104th annual meeting of the Swiss Society for Natural Sciences will be held on August 30–September 2 at Zermatt. This will be the fifth occasion when the Society has met in the Canton of Valais. The work of the meeting will be divided into fifteen sections as follows: (1) Mathematics, (2) physics, (3) geophysics, meteorology, and astronomy, (4) chemistry, (5) geology, mineralogy, and petrography, (6) botany, (7) zoology, (8) entomology, (9) palæontology, (10) anthropology and ethnology, (11) medical sciences, (12) history of medicine and the natural sciences, (13) veterinary medicine, (14) pharmacy, and (15) engineering science. In addition to the sectional gatherings, there will be general discussions which will be addressed by distinguished men of science. Among the topics thus dealt with will be: Phylloxera in Valais, by Dr. H. Faés, director of the Federal Viticultural Station, Lausanne; earthquakes in Switzerland, by Dr. A. de Quervain, of the University of Zurich; and the geology of the neighbourhood of Zermatt, by Prof. E. Argand, professor of geology, palæontology, and petrography in the University of Neuchâtel. The following officers have been appointed for the meeting: *President*, Rev. C. M. Besse; *Vice-President*, Dr. J. Amann; *Treasurer*, M. E. de Riedmatten, and *Secretary* M. A. de Werra, of Sion, Valais.

THE National Research Council of the United States has issued as a Bulletin an account of the State Research agencies of Illinois other than the University, prepared by Prof. L. D. White of the University of Chicago. These agencies spent 40,000*l*. on research during the fiscal year 1921-22, employing 230 scientifically trained workers. The smallness of the grant is due largely to the claims for research being subject to review by non-professional administrators who have no very definite understanding of the aims of research. The salaries paid to the research workers are small, and the best men are attracted by the posts open to them in industry. While managing officers receive from 500*l*.-1000*l*. per annum, engineers, geologists, naturalists, and bacteriologists from 300*l*.-700*l*., and medical officers and psychologists 350*l*.-570*l*., chemists receive only 250*l*.-450*l*. per annum. The report recommends that research officers should be relieved of routine work, that the University should be recognised as the central research agency, and that the salary scale should be equal to that maintained in the University for persons of similar professional attainments.

THE Årsbok for 1922, Part II., of the Swedish Meteorological Service gives full details, accompanied by maps, of the precipitation in Sweden. For each month of the year are given a summary of the fall for each province, with a comparison of the mean average fall, and the details of several hundred stations throughout the country. For each station are given the total fall in the year, the total for the wettest day, and the number of days with precipitation more than certain amounts. There are maps of the monthly and annual distributions of rainfall, and a large map showing the distribution of the recording stations.

BULLETIN No. 13 of the Madras Fisheries Department (1922) contains the Reports on Administration for the years 1919–20. The publication is, however, a notable one in that it also contains a long report (pp. 35 to 266) by Sir Frederick Nicholson on methods of fish canning, preparation of oils, guano, etc., with special reference to local methods. There is also an interesting account of the "solar oven," a contrivance for entrapping the heat of the sun in a confined atmosphere. With an outside temperature of 140° F. that of the inside of the oven reached 325° F.

IN the July issue of the *Antiquaries Journal*, Sir Hercules Read publishes his presidential address delivered on St. George's Day. It is devoted to the question of collaboration in archæological research with foreign nations, in particular with France and the United States. Special attention is paid to the question of an agreement with the Afghan Government which granted to the French through M. Foucher a perpetual monopoly of archæological investigation in Afghanistan. This was a serious invasion of the rights of India to share in the excava-

tion of the important Buddhist sites beyond its north-western frontier. It is satisfactory to learn that the matter has now been amicably arranged. The French Government has also expressed readiness to welcome the collaboration of British investigators, and the existence of the concession will not affect their participation.

A LIST of the new books and new editions added to Lewis's Medical and Scientific Circulating Library during June has just been issued by Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, W.C. 1. It is sent free upon request.

MESSRS. J. AND A. CHURCHILL announce the early publication of the translation of vol. 2, pt. 2 of Molinari's "Organic Chemistry," completing this section of the work. The new part will deal with the esters, oils and fats, sugars and other carbohydrates, cyclic compounds, dyestuffs, textile fibres, proteins, etc.

UPWARDS of 1600 works in botany, zoology and general natural history, many of which are rare, are included in the latest catalogue (New Series, No. 8) of Messrs. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2. They originally belonged respectively to Prof. G. A. Boulger, Mr. F. N. Campbell, Sir F. W. Moore and Sir Edmund Giles Loder, Bart. The list is worthy of perusal.

AMONG the announcements of Messrs. Ernest Benn, Ltd., are "The Art of the Chinese Potter," by A. L. Hetherington and R. L. Hobson, which will illustrate 192 choice examples of pottery dating from the Han Dynasty to the end of the Ming, in a series of coloured and half-tone plates; "The Art History of Ancient Peru," by Drs. W. Lehmann and H. Döring, being the first publication of the Research Department of the Ethnographical Museum, Berlin, and "Introduction to the Study of Chinese Painting," by A. Waley, which will be compiled almost entirely from native texts, few of which have been translated before.

Our Astronomical Column.

D'ARREST'S COMET.—No news of the detection of this comet is yet to hand; this is not altogether surprising, as it has been noted faint at previous returns; and as it has not been seen for two revolutions, the positions given may be somewhat in error. The search is still possible in August; in fact, the maximum brightness is in the last week of August. The following is a continuation of Mr. F. R. Cripps's ephemeris (for midnight):

	R.A. h. m.	Decl.	log r.	log Δ.
July 28.	16 29·6	4° 39′ N.		
Aug. 1.	16 32·8	2 45	0·160	9·837
5.	16 37·1	0 46 N.		
9.	16 42·1	1 17 S.	0·151	9·837
13.	16 47·2	3 24		
17.	16 54·1	5 34	0·143	9·840
21.	17 1·5	7 46 S.		

r, Δ are the distances from sun and earth in astronomical units.

The comet should be looked for about 20° west of south, as soon as the sky is dark.

THE CEPHEID VARIABLES AND THE DISTANCE OF THE CLUSTERS.—These variables were largely used by Prof. Shapley in his deduction of the distances of the globular clusters. In the last two years both Prof. Curtis and the late Prof. Kapteyn have challenged these distances; they suggested values about one-seventh of Shapley's. Kapteyn's result was based on all the available proper motions of the Cepheids; he concluded that these were larger than would be expected on Shapley's formula of their distance. Mr. R. E. Wilson, of Dudley Observatory, Albany, returns to this question in *Astron. Journ.* No. 821; he uses all Kapteyn's material, together with a considerable amount of new matter, so that his list contains eighty-four stars. He divides them, as others have done, into the short-period cluster type, and those with periods exceeding two days. Mr. Wilson has also collected observations of radial velocity for thirty of these stars, six being of type I. His conclusion is that these short-period variables are rapid movers in space, the indicated velocity being of the order of 100 km./sec. He therefore considers that Kapteyn's distances for these stars, which were based on a much lower assumption of linear speed, are too small. The stars of longer period are presumably more massive, and their peculiar speed is found to be 12 km./sec. Wilson's estimate of the cluster distances is of the same order as Shapley's, but he suggests a reduction of the latter by an amount not exceeding 40 per cent.

Mr. Wilson also uses his results to test Kapteyn's suggestion that Boss's proper motions in declination need systematic correction by the formula $+0{\cdot}013''$ cosine decl. The material is too scanty to give a conclusion, but it suggests that a correction of half the size indicated by Kapteyn is needed.

PHOTOGRAPHY OF METEORS.—The great difficulty in "catching" a meteor on a photographic plate is referred to by Dr. Harlow Shapley in a brief report on a photographic survey for bright meteors (Harvard College Observ. Bull., No. 788). Harvard College possesses a series of plates extending over an interval of twenty-three years. Each plate covers more than twelve hundred square degrees, and the average length of exposure is sixty-nine minutes. These plates show stars to the eleventh photographic magnitude or fainter, and were made with a one-inch Cooke lens of thirteen inches focal length. The most striking result of this systematic examination of 641 direct photographs is the infrequency of meteor trails. Four sets of regions and time intervals were so chosen that each included the radiant point and the date of a well-recognised meteor shown, and the total exposure time for all these plates amounted to 44,266 minutes. Thus, as is stated, the present survey is equivalent to a photographic search for bright meteors for 738 hours over a region with a diameter of nearly forty degrees, and yet only twelve meteors were recorded. The results are briefly summarised as follows:

	No. of Plates.	Total Exposure min.	Meteor Trails.
Perseids . . .	95	6,379	3
Orionids . . .	93	6,250	0
Leonids . . .	143	9,528	1
Andromedids .	310	22,154	8

ERRATUM.—Meteor of July 11, p. 110, last line. For "15° W. of south" read "15° E. of south."

Research Items.

THE SCOTTISH TABOO OF PORK.—In the memoirs of the Manchester Literary and Philosophical Society (vol. 661), Mr. Donald A. Mackenzie investigates the Scottish objection to the use of pork. He remarks that while the Celts, the medieval clergy, Angles, Saxons, Vikings, and Flemings settled in Scotland reared swine and ate their flesh, the prejudice against this meat was perpetuated by the descendants of the indigenous races, the common folk. The prejudice in the Hebrides has been acquired from them, and James VI. of Scotland and some contemporary lords likewise succumbed to the taboo. Mr. Mackenzie doubtfully traces the belief to Egypt, where Set, the slayer of Osiris, "was the prototype of the Satanic pig demon," and the cult of the pig was associated with that of the Great Mother.

PRIMITIVE STONE WEAPONS FROM UGANDA.—In the publication of the Geological Survey of Uganda (Occasional Paper No. 1) Mr. R. A. Smith of the British Museum and Mr. E. J. Wayland, director of the Geological Survey, Uganda, describes a collection of stone implements made in that province. A report on some of the implements, resembling the rostro-carinate type from below the Suffolk crag, has been already published by Mr. Reid Moir (NATURE, July 21, 1921, p. 649). As only a selection of those implements has come to Europe, Mr. Smith believes that "it would be premature to use these types as evidence of date, in reliance on parallel forms elsewhere; but the palæolithic character of thousands of flints from Egypt is now generally admitted, and the publication of a new series from Uganda may throw light on the Stone Age of Africa in general."

RUGBY AND HOCKEY IN ANCIENT GREECE.—In the April issue of *Discovery*, Mr. Stanley Casson directs attention to one of the most remarkable finds of Greek sculpture in the city wall of Atticus, near the so-called Theseium. These have been already published in the *Journal of Hellenic Studies* for 1922. In one of the reliefs, the players are grouped round an imaginary central line which divides the relief into two equal parts. The six players thus form two teams of three. The foremost on each side is moving at a moderate pace, the central figures at a faster pace, and the figures at the back of each team at a slow pace, almost a walk. To use modern Rugby terms, they might be called "forwards," "three-quarter-backs," and "full-backs." The team that appears to be advancing has possession of the ball, which is a small one, and is held in the hand of the "full-back." Mr. Casson goes on to show that four games of ball, one the Athenian form of Rugby, are described in the "Onomasticon" of Julius Pollux dedicated to the Emperor Commodus, about A.D. 177, which may be described as a "young man's guide to University life." The relief depicting the Athenian equivalent of hockey is of equal interest.

ANATOMY OF THE SHIELD-URCHINS.—Prof. Koehler of Lyons has taken the opportunity presented by his account of the Echinoidea in the Indian Museum (Calcutta, 1922) to study, so far as the state of the material permitted, the internal anatomy, particularly that of the gut, in the Clypeastroida or shield-urchins. He has discovered a composite gland, lying along the front part of the ventral coil of the intestine, and presumably pouring into it some digestive secretion. This intestinal gland was found in all those of the Clypeastroids examined that had the auricles for the attachment of the jaw-muscles separate, but not in those where the auricles were fused into inter-radial processes. The classification based on that skeletal feature thus receives confirmation; but the correlation is no doubt primarily physiological. The arrangement of the intestinal siphon (or by-pass) is also found by Prof. Koehler to vary according to the families already recognised. The relation of the internal calcareous pillars of the Clypeastroids to the soft parts is patent: it can be detected even in the fossils. Prof. Koehler has therefore little difficulty in showing the importance of this so-called "endoskeleton" for classification. The only difficulty that might arise, namely, the reluctance to break open a rare specimen, is, as his excellent photographs prove, easily overcome by radiography. This important memoir on recent sea-urchins will thus strengthen the student of their fossil relatives in his conviction that he is proceeding on safe lines when he bases his genealogies on minute differences of skeletal structure.

MYXOSPORIDIA PARASITIC UPON JAPANESE FLAT FISHES.—In the Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan, T. Fujita shows that the flat fish of Hokkaido are more highly susceptible to the infection of myxosporidian parasites than the allied forms in the North Sea, the infecting ratio of the parasites being 94 per cent. in the species of the hosts, and 68 per cent. in 453 fishes examined. Observations were made on the gall bladder, this being the most favoured site of the parasites. The species of parasites found are of three genera and eleven species—three of Leptotheca and four of Ceratomyxa and of Myxidium. All are new species. Usually only one was found in a species of the host, though Myxidium was found existing with Ceratomyxa or Leptotheca; the two latter rarely associated together. Ceratomyxa gives the greatest infection and predominates on the east coast. The other genera named are found mostly on the west coast. There appears to be some relation between the occurrence of the parasites and the geographical position of the locality from where the fish are taken. There is an increase in frequency the farther south the fish are found. The author concludes that some parasites seem to prefer a certain depth as their proper abode, Leptotheca attacking mainly the fish in shallow seas while Ceratomyxa abounds mostly in deeper waters.

BARK CANKER OF APPLE TREES.—Part IV. of volume 8 of the Transactions of the British Mycological Society contains a paper of considerable economic interest by Grace G. Gilchrist upon bark canker disease of apple trees. This disease, due to the fungus *Myxosporium corticolum* Edgert., produces large longitudinal scars upon the branches. It has been described by American workers, who regard the damage it produces as negligible. Miss Gilchrist points out that the two outbreaks recorded for England both show severe damage produced as a result, the wood as well as the cortex of the trees being affected.

THE STRUCTURE OF THE PLANT CELL WALL.—The Journal of the Textile Institute, vol. 14, No. 4, April 1923, contains a long paper by H. J. Denham upon the structure of the cotton hair, which deals with the problem of the formation of the plant cell wall. Recent papers by Dr. W. L. Balls have suggested that the thickening of the wall follows by regular deposition of cellulose upon a plan predetermined by the structure of the primary wall which is deposited during the period of extension in length of the hair. Mr. Denham seems unable to agree with this view, as he finds that the striation

patterns of the secondary layers may differ from each other and from that of the primary wall upon which they are deposited. This difference in point of view should promote the advance of our knowledge of the wall structure, and certainly both these workers have materially added to our technique in this difficult field. One may cite, for example, the photographic illustration in the present paper of the growth-rings first demonstrated by Dr. Balls and of other wall structures, such as pits and spirals. Mr. Denham illustrates and discusses at some length the various abnormalities in cell-wall structure met with by several workers, and shows that considerable importance may attach in this connexion to the development of the hairs crowded and compressed within the boll. Based partly upon the study of the staminal hair of Tradescantia, the very interesting suggestion is made that the spiral striation in the cell wall may follow from its deposition along the track of the spirally rotating cytoplasm. Such a spirally rotating band of cytoplasm will of necessity travel in two streams, lying side by side but moving in opposite directions, and the deposition of particles from such a moving band would be expected to vary from the centre of the band to the margin. Here the author finds a possible explanation of the double spiral line of weakness which he demonstrates in the wall of the hair and regards as the cause of the convolutions which are so important to the spinner.

THE DIAMOND-PIPES OF ARKANSAS.—The first diamonds from Arkansas were picked up near Murfreesboro in 1906, on the surface of a pipe of peridotite that had been correctly appreciated by J. C. Branner seventeen years before. Abundant small stones are now extracted from surface-diggings in the decomposed peridotite or peridotite-tuff that fills exploded vents, and the associated strata clearly show that the intrusions occurred at the opening of Upper Cretaceous times. The question as to whether the diamonds were generated in the ultrabasic magma, or whether they have been brought up from some mass through which the invader broke, cannot be regarded as settled; but the list of their associates, including garnet and diopside, seems to indicate the presence of eclogitic rocks in the depths. The occurrences have now been described by H. D. Miser and C. S. Ross in Bulletin 735-I of the U.S. Geological Survey (1923). The largest diamond so far recorded from Arkansas weighs 20·25 carats, which comes within the limits of what may be regarded as a large stone. The age of the pipes is of interest in connexion with what is now known as to the S. African examples.

THE CARBONIFEROUS FLORA OF GREAT BRITAIN.—Under the auspices of the Geological Survey, Dr. Robert Kidston is bringing together the results of his long and happily continuing work on British Carboniferous plants. It is proposed to issue some ten quarto parts as Volume II. of the palæontological memoirs of the Survey, including critical descriptions and illustrations of every known species in the flora. The first two of these parts are now ready (1923), price 15*s.* and 12*s.* 6*d.* respectively. There is nothing on the covers to indicate to the purchaser that he is not receiving the whole work on the "Fossil Plants of the Carboniferous Rocks of Great Britain" in the limits of one part, and the separate sheet issued with Part 2 would lead him to conclude that he was dealing with the second part of the second volume of the book. The final title-page will set this right for our librarians. So far, all the species retained in the "form genus" Sphenopteris have been dealt with; but it is suggested that some may in the future be removed from the ferns to the pteridosperms as their mode of fructification becomes known. The photographic plates, by the Zinc Collotype Co. of Edinburgh, are admirable in the lighting of the specimens. Dr. Kidston's broad outlook makes the memoir a noble contribution, not only to palæontology, but to stratigraphy. On the latter point we may note that the author adopts "Westphalian," but not "Viséan," "Tournaisian," or our own broad "Aronian," and that the "Millstone Grit" horizons become divided (p. 14) between a "Lanarkian" series in the Upper Carboniferous and the highest beds of the Limestone series in the Lower Carboniferous sub-system.

THE SALTS OF THE DEAD SEA AND RIVER JORDAN.—In the *Geographical Journal* for June Mr. W. Irwin has a paper on this subject. Analyses of samples of Dead Sea water show considerable variation according to the spot from which the sample is taken, but the total solids do not vary greatly. The outstanding change is a decrease of sodium salts and an increase of magnesium salts on passing from the north to the south, and to the deepest part of the centre of the lake. This alteration can be caused only by the sodium salts crystallising out on the bottom, leaving the more soluble magnesium salts in solution. Tests of Jordan water show a surprising salinity, averaging, at Jericho, 0·0364 gm. chlorine per 100 c.c. Further analyses in different stretches of the river gave interesting results. As near its source as the Waters of Merom it is highly impregnated with salts, chiefly chlorides of sodium and magnesium, and the composition of the water does not change as far as the Sea of Galilee. In the Sea of Galilee there is a slight increase in these chlorides and a decrease in calcium sulphate and silica, due no doubt to evaporation on one hand and precipitation on the other. By the time the river reaches Jericho there is an increase of salts, especially magnesium chloride. The result of these investigations is to suggest that the principal origin of the salt in the Dead Sea is from the Jordan, which brings it from Hermon and possibly Lebanon. Assuming the bulk of magnesium chloride to be provided by the Jordan, the present level of the Dead Sea must be rising at the rate of 1 ft. in 125 years, for the Jordan brings in 181 million pounds a year, and if the solution is already concentrated and none crystallises out, as appears to be the case, an annual additional depth of water estimated to be 1/125 ft. is required.

WEST INDIAN EARTHQUAKES.—Prof. S. Taber has recently published an interesting study of the seismic belt in the Greater Antilles (Bull. Seis. Soc. America, vol. 12, 1922, pp. 199-219). In this region, the major relief features are zones of normal faulting developed in late geological times, and still, as the occurrence of earthquakes shows, being developed. The two most persistent fault-zones are the Swan Island–Jamaica–South Haiti and the Cayman Islands–Sierra Maestra–North Haiti, which are roughly parallel for a distance of nearly 2000 km. and are only 100 to 150 km. apart. The narrow strip between these fault-zones is depressed in its western and central portions so as to form the Bartlett trough (3506 fathoms). With few exceptions, all strong Antillean earthquakes have originated along a few well-defined belts which coincide with the major fault-zones of the region. There is no evidence either of a continuous change in the seismicity of the region or of any well-defined periodic variation. When severe earthquakes have been separated by a short time-interval, their epicentres have been in the same fault-zone and only a short distance apart, thus indicating that the displacement was being

extended along the strike of the faults. Most of the great earthquakes originating along the shores of the islands have been accompanied by sea-waves, each of which, so far as known, has been propagated with the trough in advance of the crest. The wave thus seems to indicate a sudden downward displacement of the ocean-bed. Disastrous earthquakes seldom recur in exactly the same place except after long intervals. Thus, those parts of the zones of active faulting near which severe earthquakes have not occurred in historic times are to be regarded as seismically the most dangerous.

VOLUMETRIC DETERMINATION OF RAINFALL.—A paper on this subject by Mr. C. S. Salter was read before the Inland Navigation section of the thirteenth International Congress of Navigation held recently in London, and is published as a pamphlet. The sources of error in rainfall records are three: design of rain-gauge, exposure of rain-gauge, and interpretation of records in terms of volume. Mr. Salter's paper deals with the last consideration. Owing to the fact that rainfall is extremely variable in its incidence in time and its distribution in space, the reading of an individual rain-gauge must be regarded as merely a sample. The total rainfall of an individual month in Britain may vary by 400 per cent. from the average value, and that of an individual year by 70 per cent. When the period of records is short no allowance for the variation of time is possible, but a correction can often be applied from adjacent long records. Generally speaking, in rainy districts, where thunderstorms and sporadic rains do not bulk largely in the total fall, from one to two years give a sufficiently good basis for a factor of correction to be applied with safety, provided that a long record is available at no greater distance than five to ten miles. In districts where the total fall is so small that a single thunderstorm may introduce great local variations, from four to five years' records are necessary. Variations in space are relatively easily applied with the help of an orographical map. A rainfall map is the best medium for computing the volume of rainfall over a gathering-ground as a whole, and the best and simplest method is by planimeter measurement.

THE WINDS OF HONGKONG.—A discussion under the direction of Mr. T. F. Claxton "to ascertain the difference in direction and velocity of the wind at the Royal Observatory, Kowloon, and at Victoria Peak, Hongkong, at different seasons of the year and at different hours of the day," has been issued by the Royal Observatory, Hongkong. The results are based on the records of Beckley anemographs for the period 1914-1918. The Royal Observatory is situated on a hillock, 100 feet high, about 1000 yards from the harbour; the surrounding country is flat, except to the north. Victoria Peak is 1840 feet above sea-level and is situated 3 miles to the south-west of the Royal Observatory. To the north, west, and south, the sides of the Peak are very steep, and the easterly winds are affected by the Hongkong hills. The anemograph records at the Observatory are measured at the half hours, and the value set against any hour is the run of the wind from 30 minutes before to 30 minutes after that hour. At Victoria Peak the records are measured at the hour, and the value set against any hour is the run of the wind since the previous hour. This difference in the method of registration seems likely to affect the results for comparison. Detailed hourly observations of direction and velocity are given for the two exposures for the years 1914–1918. The different situations naturally give different results, which are shown by numerous tables and diagrams. For normal wind results, for comparison with other world observatories, the results at Victoria Peak should probably be preferred, although both situations seem to leave much to be desired.

IONIC DISSOCIATION IN SOLUTION.—P. Debye and E. Hueckel have investigated the electrostatic forces between the ions of the solute, and the dipole action of the molecules of the solvent (*Phys. Zeits.*, May 1). They assume that the whole of the dissolved salt is dissociated; and for dilute solutions arrive at the equation

$$\theta = w\frac{\epsilon^2}{6\mathrm{D}k\mathrm{T}}\sqrt{\frac{4\pi\epsilon^2}{\mathrm{D}k\mathrm{T}}n\Sigma\nu_i}, \tag{1}$$

where θ, the deviation from the classical theory, $=(\Delta_k - \Delta_i)\Delta_k$, Δ_k being the lowering of the freezing point given by the classical theory and Δ_i that actually observed; w is a valency factor equal to $(\Sigma\nu_i z_i^2/\Sigma\nu_i)^{\frac{3}{2}}$. The dissolved molecule is split up into $\nu_1 - \nu_i - \nu_s$ ions of different kinds $1 - i - s$, with valencies $z_1 - z_i - z_s$, and w is calculated from these values; $\mathrm{T}=273$ when the solvent is water, $\epsilon = 4\cdot77\times10^{-19}$ e.s.u., n is Loschmidt's number $= 6\cdot06\times10^{23}$, $k = 1\cdot346\times10^{16}$ ergs, D, the dielectric constant, is 88·23 for water at 0° C., $\Sigma\nu_i = \nu$ is the number of ions into which a molecule of the salt splits up. Using these values,

$$\theta = 0\cdot270 w\sqrt{\nu\gamma}; \tag{2}$$

and curves have been drawn showing the experimental relation between θ and $\sqrt{\nu\gamma}$ for a number of salts of varying constitution, including magnesium sulphate, lanthanum nitrate, potassium sulphate, and potassium chloride. These curves follow the straight lines obtained by giving w in (2) the proper values, for a considerable distance from the origin. For higher concentrations the deviations from the straight lines depend on the individual properties of the ions; and particularly on their dimensions, which were neglected in deriving (1) and (2). When the dimensions are taken into account, theory is found to agree very satisfactorily with experiment up to much higher concentrations. For very high concentrations other factors, previously neglected, have to be considered; there appears to be no doubt that, even in this case, the molecules of the solute are split into their ions.

STEREOSCOPIC PROJECTION.—Much attention has been directed in recent years towards obtaining a satisfactory method of stereoscopic projection. Many of the devices proposed involve the use by the individual observer of spectacles or binoculars with coloured glasses or interrupting shutters. The Daponte Stereoscopic Projector or "Pulsograph," which was exhibited by Mr. E. Sanger-Shepherd at the Royal Society Conversazione on June 20, employs an entirely different principle, whereby a "stereoscopic" effect can be readily observed by the unaided eye of the spectator. Two photographs are taken from two positions slightly separated, and projected in register on an ordinary screen by two optical systems. Between the source of light and the transparency in each of the optical systems a rotating shutter is placed, consisting of a glass disc with a graduated grey film varying from black at zero to clear at 180° and back to black at 360°. When one shutter is passing maximum light the other is at minimum transmission position, the rotating shutters dissolving the right-hand picture into the left-hand picture and *vice versa*. With the discs at the position of equal transmission, that is at the 90° position, a double-image picture appears, since the two stereoscopic photographs are not exactly alike; but on the discs being rotated the "stereoscopic" relief effect is immediately obtained. The "Pulsograph" can be employed for the projection of lantern slides, solid objects, or of kinematograph films.

Problems of Fundamental Astronomy.[1]

By Prof. W. DE SITTER, University of Leyden.

THE science of astronomy has, in the past twenty or thirty years, developed most remarkably. The marvellous applications of photography and spectroscopy on one hand, and the sudden growth of statistical stellar astronomy consequent upon the discovery of the two star-streams on the other, have led to so many unforeseen results and so many new points of view, that it almost appears as if the whole science were born anew and the astronomy of to-day had only very slight connexions with that of the last century: we are apt to think that the great problems of the past have lost all their interest to us. This, however, is not so. On the contrary, I think the central problems of fundamental astronomy have gained an enhanced importance even by the newest developments of the science.

Astronomy is essentially the science of space and time. It is not my intention, in thus assigning to astronomy this wide field, to annex to it the whole of physical science. On the contrary, I am quite content to consider astronomy only as a special branch of physics, but, having at its disposal the largest spaces and the longest times, it has generally had the last word in all important questions. To mention only a few cases at random: the discovery of gravitation, of the finite velocity of light, and of aberration, all these are astronomical discoveries, and the three crucial tests of Einstein's theory are all three astronomical.

In our exploration of space and time we are compelled to make all our measures from this earth, to which we are tied, as a starting-point. The problems of fundamental astronomy are those which arise from this fact, that all our observations are necessarily referred to a moving origin. These problems are, from their nature, not very liable to change of aspect with time or fashion; they are essentially the same to-day as they were in the time of Hipparchus, the founder of astronomy, and they will remain the same so long as science lasts, and will require ever more accurate and more complete solutions, as we penetrate more deeply into the constitution of the universe. Fundamental astronomy thus consists essentially of a scrutiny of the last decimal place. This striving after extreme accuracy, this fidgeting over small quantities, may appear uninteresting, or even pedantic. But we must not forget that great problems always turn about the measurement of small quantities.

The problems of fundamental astronomy are, of course, all interconnected with each other, but, for the sake of clearness, they may be classified under three heads. There are, first, the problems connected with the system of constants. The motion of the earth, and the system of measurement based on it, are defined by several numbers, such as the solar parallax, the constants of precession and nutation, the ellipticity, the mean radius and the mass of the earth, etc. Between these several constants there exist relations, connecting two or more of them with each other and with other universal constants such as the velocity of light and the constant of gravitation. The problem here is essentially one of adjustment, so as to get a consistent set of constants satisfying all the connecting relations. The set of constants in actual use in the national ephemerides is not consistent. The discordances are, however, not very large, and changes should not be introduced unless by general international agreement.

Another set of problems are those connected with the rotation of the earth. The paramount practical value of this rotation is that it is used as our standard measure of time.

Time is measured by observing the changes occurring in some physical system—*i.e.* in the relative positions of some material bodies, which positions at any time are determined by our theories, so that from the observed positions we can infer the time. Such a mechanism—by preference periodic—that is used to measure time may conveniently be called a "clock." But there is no absolute measure of time, nor an absolute test of the accuracy of any clock; we can only test one clock by another. If the two do not give the same time, then one or both must be wrong, *i.e.* our theories of the mechanism of one or both must be incomplete. The standard clock to which all others are generally referred is the rotating earth. Is this standard absolutely trustworthy? Do all observatories give the same time, and if so, is this a truly uniform time? In other words: does the earth rotate as a rigid body, and if so, is this rotation strictly uniform?

It has long been suspected that the earth's rotation is very gradually slowing down, owing to the friction of the tidal wave.[2] But lately other doubts have arisen as to the trustworthiness of our universal standard. As a matter of fact, it is not the rotation of the earth, but the rotation of a definite point on the earth—Greenwich Observatory or any other observatory—that is used as our standard, and now that the wireless distribution of time signals has made comparisons so easy, occasional discrepancies between the times of different observatories, amounting sometimes to several tenths of a second, have come to light.[3]

It appears probable that these are due to errors in one or more of the parts of the mechanism used to determine the time at some or all of the observatories—the transit instruments, the clocks, the astronomers—but it also may be that they are due to real differences in the rotation of the different observatories, which would mean that the earth does not rotate as a rigid body, but some parts of its surface are moving relatively to other parts.[4] Here evidently is a most important problem, the solution of which must be found sooner or later.

Besides the rotating earth, we have other "clocks," of which the moon must be mentioned in the first place. It is well known that in the motion of the moon there are irregularities of a much longer period, called "fluctuations" by Newcomb, for which no explanation has yet been found. Brown[5] and Glauert[6] have pointed out similar irregularities in the motions of the sun, Venus, and Mercury. If this were confirmed, and if also other bodies—especially Jupiter's satellites—should show the same thing, then it would become very probable that the true origin of these fluctuations is in the rotation of the earth, or at least of the outer crust of the earth.

Other problems connected with the rotation of the earth, and the question whether it rotates as a rigid body, are those involved in the variation of latitude.

[1] Synopsis of a lecture delivered at the Imperial College of Science and Technology, South Kensington, on May 7.

[2] Taylor, Mon. Not. R.A.S. lxxx. 308; Jeffreys, *ibid.* 309.

[3] Sampson, Mon. Not. R.A.S. lxxxii. 215; Dyson and Bowyer, *ibid.* lxxxii. 193.

[4] Dr. Innes (Johannesburg Circular 55) has recently directed attention to irregularities in the moon's motion of the same character as the discordances between the times of different observatories referred to above. But these are derived from several observatories, giving concurrent results, so that it would appear that the error is in the moon, and not in the time.

[5] Brit. Assoc. Report, Australia, 1914.

[6] Mon. Not. R.A.S. lxxv. 489.

There seems to be evidence[7] of sudden as well as slow and continuous changes, which, if they are real, may be due either to shifting of parts of the crust of the earth relatively to each other, or to a slow sliding of the whole of the crust over the core.

All these problems, which evidently are of the greatest importance not for astronomy alone, depend for their solution on very small quantities which even now only begin to come within the reach of our most accurate measures and most refined discussions.

The third set of problems of fundamental astronomy concern questions relating to the positions and motions of the fixed stars. Bessel's great work called "Fundamenta astronomiae" consists of a careful discussion and synthesis of the observations made by James Bradley as Astronomer Royal at Greenwich upon the positions of the stars.

Indeed, the positions and motions of the "fixed" stars are the basis on which the whole structure of astronomy rests. The manner in which these positions are determined is forced upon us by our location on the moving earth. The accumulated labours of astronomers since the commencement of accurate observing by Bradley have resulted in a system (or rather three systems, differing by small, but not negligible, quantities) of positions and motions of the stars. These are referred to a frame of reference, which is defined by the motion of the earth, and consisting of the equator, and a zero point on it. Both the equator and the zero point are moving. It need scarcely be stated that the formation of such a system of positions and motions of stars is a most intricate and difficult problem, and we must confess that it has not, so far, been solved in a manner which satisfies the demands of statistical astronomy and cosmogony.

The system which is generally considered the best of those now in use, that of Boss, is by no means perfect: large errors in it are not at all improbable.[8] These errors are errors of the system, not of the individual star-positions, and the question naturally arises: Is an "absolute" system at all necessary? Strictly absolute, of course, it is not: all systems of reference are relative. By "absolute" we mean relative to the inertial frame defined by the motion of the earth in the solar system. But is it necessary to base our system of star-positions on this motion of the earth? Would it not be much more natural, and much more simple as well, to have relative positions and motions of the stars with regard to one another, or to the general average of them?

Many astronomers are inclined to answer this question in the affirmative, and to consider the absolute system more as a time-honoured institution of our predecessors, a venerable relic from the pre-photographic days, than as a useful and necessary adjunct of modern stellar astronomy. In fact, by the application of photography, we can easily derive relative motions, or motions of individual stars relatively to the "background," with an accuracy which many times exceeds that attainable by fundamental methods.

By the blink-microscope we find, with comparatively very small labour, proper motions of very satisfactory accuracy referred to the background of faint stars in the area examined. Of course this "background" is a rather loosely defined frame of reference, and we have no guarantee that the motions of stars in different areas of the sky are really referred to the same frame. A more elaborate method of referring the relative motions determined photographically to a quasi-absolute system is proposed by Kapteyn.[9] This method, however, depends on the hypothesis that the sun's motion relative to faint stars is the same as that relative to bright stars. This is why I call it a "quasi-absolute" system. Are not the proper motions derived by these and similar methods quite as valuable as those found by fundamental methods?

My answer is decidedly in the negative. We cannot do without the "absolute" system of fundamental astronomy. The value of that system is not that it is attached to the earth, but that we know exactly what the frame of reference is and that it is a rigorous system, giving certainty that all motions are really referred to the *same* frame. To see the importance of this, I will put some questions, which cannot be answered until we have a fundamental system including the faint stars.

Is star-streaming a universal phenomenon, or is it local, and in the latter case, how far from the sun does it extend? Do the Orion-stars take part in the star-streaming or not? Is there a systematic motion of faint stars relatively to bright stars; or in other words, is the average motion in space of the stars independent of their brightness?[10] Is there a rotation of the system of stars as a whole?

These and similar questions are again examples of great problems the solution of which depends on very small quantities. These small quantities, the proper motions of faint stars, cannot be profitably discussed unless we have the certainty that these motions are referred to a rigorous system.

The necessity of a fundamental system being granted, we must next ask: how are we to improve and extend our present system? Must we, in order to establish an absolute system, necessarily retain the old methods, or can we find other means? Is the meridian instrument to remain the only one by which star places are to be determined? To this question I wish, as emphatically as to the former one, to answer in the negative. We must look for other methods, if it be only to verify the results from the meridian work.

Here I think is the greatest problem, and the most urgent problem, of fundamental astronomy. It is twofold: the determination of the positions of the stars, and that of their motions. We must thus not only establish a rigorous and faultless system of star positions for the present day, but also strengthen as much as possible our knowledge of the positions in the past. These latter as now used depend practically exclusively on Bradley's observations. But there are other data available, though not yet, or not yet sufficiently, reduced. Among these the most important are the rich mine of material still lying unused in the observations made in the last quarter of the eighteenth century and the first quarter of the nineteenth by Hornsby and Robertson at Oxford.[11] I think the careful reduction of these observations, which are of the same excellent quality as those of Bradley, is one of the most urgent demands of fundamental astronomy.

As to the means by which the modern positions must be determined, I will not attempt now to enter into details regarding the methods which have been, or may be, proposed to supplement the classical meridian methods. All I wish is to convey an idea of the meaning and the importance of the problems of fundamental astronomy, and to show that far from being uninteresting remains of a past period, their solution has become even more urgent by the newest developments of several branches of modern astronomy.

[7] Lambert, U.S. Coast and Geodetic Survey, Serial No. 183, giving many references to other papers.

[8] See *e.g.* Kapteyn, B.A.N. 14.

[9] Groningen Publications, 28.

[10] A considerable difference in average velocity would arise if the percentage of high-velocity stars (cf. Oort, B.A.N. 23) were not the same for all magnitudes.

[11] See Rambaut, Mon. Not. R.A.S., lx. 265.

Night Temperature on Mt. Etna.

THE observatory on Mt. Etna is perched high up on a plateau of the volcano known as the Piano del Lago beneath the summit ridge, which rises about 1000 feet higher. It is sometimes noticed by the officials, who only reside a few days in each month, that a curious rise in temperature, amounting to a couple of degrees or so centigrade, occurs during the middle of the night, constituting a well-marked secondary nocturnal maximum in the diurnal variation of temperature. During a visit to the station in August 1920, Prof. Filippo Eredia noticed that the nocturnal inversion in the regular fall of temperature was associated with the arrival of sulphurous fumes from the crater, but notwithstanding the contemporaneous occurrence he does not attribute much causal connexion between the two phenomena. A dozen cases, as shown by thermograph records, are discussed by him in a paper contributed to vol. 31 (1922) of the Rendiconti della Reale Accademia Nazionale dei Lincei. Most of them occurred in the summer, and in conditions both of calm and of wind of different forces and directions, chiefly N.E. and N.W. The calm cases with clear sky are shown to be analogous to similar nocturnal inversions in other mountain regions, and are attributed partly to the slow descent of air from the summit ridge whereby it is warmed by adiabatic compression, and partly to the latent heat of misty condensation due to the previous general nocturnal chilling of the atmosphere. This, however, is not quite convincing; the effects are too complex to be explained on a purely qualitative basis. The cases with strong wind are found to be associated with a great difference of temperature between the interior of Sicily and the eastern flanks of Etna, giving rise to a circulation which carries warmer air to the high-level station. At Catania on the coast near sea-level there are no corresponding night inversions of the diurnal range of temperature.

Although the above are only examples of secondary night maxima, the inversion of the regular variation not being nearly marked enough to override the primary day maximum in 24 hours, it is probable that in the latitude of Sicily, where the range of temperature between day and night is at all seasons large, such minor irregularities in the diurnal course of temperature attract more attention than they would in a higher latitude, where during the very short days of winter the diurnal range is small and liable to be obliterated, or even occasionally entirely inverted, by the very rapid and conspicuous irregular variations of temperature. In England, for example, during the month of December it is no very rare event for night to be warmer than day: for should frosty air begin towards evening to be replaced by a warm, humid current from the Atlantic, not only will the frost be swept away, instead of intensified, as night comes on, but the thermometer may easily rise to 50° F. or above in the middle of the night.

L. C. W. B.

The School of Hygiene in London.

AN inquiry at the Ministry of Health relating to the proposed School of Hygiene in London has elicited the following statement of the position of the scheme.

In May 1921 the committee on Post-Graduate Medical Education, under the chairmanship of the Earl of Athlone, published its report, recommending, *inter alia*, the establishment of an Institute of Medicine in association with the University of London, in which instruction should be given in public health and other departments of medicine. This suggestion was further explored by a small Departmental Committee and detailed proposals were formulated.

The University of London and the Government were, however, unable to find the money to establish an Institute of Medicine such as Lord Athlone's Committee had contemplated, and in these circumstances the proposals were brought to the notice of the trustees of the Rockefeller Foundation, whose representatives had recently been in consultation with the authorities in Great Britain. The trustees of the Foundation generously agreed to provide two million dollars for the establishment of the Institute, to be called the School of Hygiene, the British Government undertaking to make an annual grant towards the upkeep of the School. Preliminary work was undertaken for the preparation of plans and estimates, and a site has been selected.

It has been decided that the School when established shall be affiliated with the University of London but managed by a separate governing body, for which a charter of incorporation will be sought. Pending the presentation of a petition for the charter, the Minister of Health, with the concurrence of the trustees of the Rockefeller Foundation, has appointed a transitional executive committee. The functions of the committee will be to appoint a director, to arrange for amalgamation or co-ordination between the School and other institutions working in similar or closely related spheres, to prepare plans for the new School, and to begin building, unless in the meantime it has been possible to set up the permanent governing body. The members of the committee are: The Rt. Hon. Neville Chamberlain (chairman), the Rt. Hon. the Viscount Burnham, Capt. Sir Arthur Clarke, Sir Walter Fletcher, Lieut.-Col. Fremantle, Sir Harry Goschen, Sir George Newman, Sir Cooper Perry, and Sir Arthur Robinson, with Mr. L. G. Brock, of the Ministry of Health, as secretary.

University and Educational Intelligence.

ABERDEEN.—At the Summer Graduation on July 11, the honorary degree of LL.D. was conferred on Prof. J. Fraser, Jesus professor of Celtic in the University of Oxford.

Mr. William Thomas received the degree of Ph.D. for theses on (*a*) The influence of colloids on reactions involving gases, and (*b*) Inorganic complex salts.

The following prizes were awarded: Collie prize in botany and Sutherland gold medal in forestry to Mr. J. H. Hunter; Struthers medal and prize in anatomy to Mr. J. W. Foster; Lizars medal in anatomy to Mr. J. W. Foster and Mr. A. J. W. Wilkins; John Murray medal and scholarship in medicine to Mr. A. Lyall.

The University Court has decided to make first appointments, in the coming autumn, to the newly founded chair in engineering and to the Cruickshank lectureship in astronomy and meteorology.

CAMBRIDGE.—Mr. D. C. Carroll, Trinity Hall, has been elected to the Michael Foster research studentship; Dr. C. C. Worster-Drought, Downing College, has been elected to the E. G. Fearnsides research scholarship.

LONDON.—At a meeting of the Senate held on July 18, the title of reader in organic chemistry was conferred on Dr. O. L. Brady, of University College;

and the title of emeritus professor on Prof. W. D. Halliburton, on his retirement from the chair of physiology at King's College, which he has held since 1890.

The degree of D.Sc. (*Chemistry*) was conferred on Mr. Jnanendranath Mukhopadhyay (University College) for a thesis entitled "The Adsorption of Ions and the Precipitation of Suspensoids by Electrolytes."

ST. ANDREWS.—The Senatus Academicus will, on the occasion of the installation of Mr. Rudyard Kipling as rector of the University, on October 10, confer the honorary degree of LL.D. on Sir James G. Frazer, author of the "Golden Bough," and on Sir John Bland-Sutton.

Twenty-five years ago the Medical School of the University was re-organised, and Dr. A. M. Stalker was appointed the first professor of medicine under the new conditions. The successful development of the School owes much to Prof. Stalker's great abilities, to his personality, and to his veneration for the University of his adoption. Prof. Stalker having intimated his resignation of the chair of medicine, the Senatus Academicus recorded a special minute expressing appreciation of his loyal service.

The University Court has decided to proceed with a scheme for building additional storeys to the existing teaching laboratories for physics and chemistry and connecting the two by a central building.

THE University of Wales has conferred the honorary degree of D.Sc. upon Sir Charles Sherrington.

THE following awards tenable at the Imperial College of Science and Technology, South Kensington, during the year 1923–24 have been made:—By the governing body of the College: (*a*) The Henry George Plimmer Fellowship in Pathology to Mr. H. R. Hewer, for research on "The Rôle of Stimuli received by the Eye in the Colour Changes of Amphibia and Nerve Supply of the Pituitary," value about 300*l.*; and (*b*) The Gas Light and Coke Company's Research Fellowship, just established by the Company for the purpose of encouraging experimental research in relation to carbonisation, gaseous fuels and combustion, to Mr. F. R. Weston, for "The Spectroscopic Investigation of the Flames of Carbon Monoxide and Hydrogen and matters cognate thereto," value 175*l.*, together with an allowance towards the expense of the research. By the Trustees of the Beit Fellowships for Scientific Research: Research fellowships to Mr. H. W. Buston, for a continuation of his work on the "Nitrogenous Metabolism in Plants," and to Mr. O. M. B. Bulman, for research on "Stratigraphical Geology: The Fauna of the Shineton Shales," value 250*l.* per annum each.

THE coming of age of the Manchester Municipal College of Technology was celebrated on July 5 and 6 by a soirée each evening in the College buildings. The guests were received on the first evening by Viscount Burnham, the Lord Mayor of Manchester, and Alderman West. After the reception Viscount Burnham addressed the gathering and congratulated the city of Manchester on having an institution which, while forming a Faculty of the University, was in touch also with the industries of the district. He spoke of the constantly increasing need for the application of science to industry, and of the importance of selecting appropriate occupations for young people starting work. He saw in the College an efficient instrument for achieving these purposes. Among other distinguished people, Viscount Burnham was supported by the Vice-Chancellor of the University, Mr. Mouat Jones, principal of the College, and Mr. J. H. Reynolds, who was the first principal of the College. The guests were each presented with an illustrated pamphlet, "An Historical Account of the Origin and Development of the Municipal College of Technology, Manchester," written by Mr. Reynolds. The whole of this striking souvenir was produced in the Printing and Photographic Technology Department of the College.

As a mark of appreciation of Sir Michael Sadler's stimulating work for the University of Leeds during the twelve years in which he has held the office of Vice-Chancellor, it has been decided to establish a memorial in the University in the form of his portrait and a fund for assisting necessitous students. Subscriptions—restricted to 5*l.* in an individual gift—are invited for these purposes. In Yorkshire, and to past and present members of the University, the results of Sir Michael Sadler's devoted work for the development of the University are richly manifest, and the response to the appeal is sure to be ready and generous. There are in addition many who hold Sir Michael in the highest esteem, on account not only of his labours as Vice-Chancellor but also for his untiring activities on behalf of educational freedom and growth in institutions of all grades. He has been the uncrowned leader of education in England—indeed, in the Empire—for a generation, and the opportunity of expressing regard for what he has done will be widely welcomed. Contributions should be made payable to the Treasurer of the Sadler Fund and sent to the University, Leeds.

THE Universities of Oxford and Cambridge Bill to give effect to recommendations in the report of the Royal Commission of 1919–22 was read a third time in the House of Commons on Friday, July 20. The Bill provides that there shall be two bodies of Commissioners, one for each University, and directs them to make statutes and regulations in general accordance with the recommendations of the Royal Commission, but with such modifications as may appear expedient. The Universities are given the power independently of the colleges to prescribe what contribution should be made by the colleges for university purposes. The provisions of the Act of 1877 are modified, so that trusts less than sixty years old can be altered with the consent of the trustees. The Marquis of Bath, in moving the second reading, remarked that if it were necessary to reduce the amounts of the grants recommended by the Royal Commission, cuts would have to be made proportionately from the amounts for general purposes, for libraries, for women's colleges, and for extramural boards. On the motion for the third reading, Mr. J. R. M. Butler proposed an amendment amounting to a direct instruction to the Commissioners to take action by giving women full membership at once of the University of Cambridge. It was pointed out by the president of the Board of Education that it made a very considerable difference whether having appointed a number of distinguished men to control the working of a university they resolved that the House of Commons should limit their discretion. The amendment was rejected by 150 votes to 124. An amendment providing that, in making any statutes or regulations, the Commissioners should have regard to the need of facilitating the admission of poorer students to the Universities and colleges, was agreed to. The list of Commissioners includes the names of Sir A. E. Garrod, Sir T. L. Heath, Sir R. T. Glazebrook, and Sir H. K. Anderson.

Societies and Academies.

LONDON.

The Faraday Society, July 2.—Prof. A. W. Porter, past-president, in the chair.—A. **Ferguson**: On a relation between surface tension and density. Macleod has shown empirically that for a number of unassociated liquids, $\gamma = C(\rho_l - \rho_v)^4$, where γ is the surface tension of the liquid at any temperature, $\rho_l - \rho_v$ the difference between the orthobaric densities of the liquid and the vapour at that temperature, and C a constant which is independent of the temperature. This expression is referred to the power law connecting surface tension and temperature first put forward by van der Waals but not generally known, and the Eötvös equation.—U. R. **Evans**: The law of definite proportions in the light of modern research. Many of the series of solid solutions met with in alloys show a maximum *melting-point* (*i.e.* a maximum *thermal stability*) at a composition indicated by a simple atomic formula (*e.g.* AuMg); it is customary to describe this member of the series as an "inter-metallic compound," and to regard it as the parent of the series. But in cases where there is a maximum *hardness* (*i.e.* maximum *mechanical stability*) at a composition indicated by a simple atomic formula (*e.g.* AgAu), or where there is an abrupt change of chemical behaviour (a *parting limit*), it is not at present customary to apply the word "compound.". The fact that the maximum stability usually occurs at a composition expressible by a simple formula is often capable of a physical explanation. Many of the oxides of metals with more than one valency have a variable composition; *e.g.* pure Fe_3O_4 and Fe_2O_3 may be regarded as the "end-members" of a series. Likewise homogeneous bodies of variable oxygen-content occur among the oxides of platinum, iridium, nickel, molybdenum, tungsten, and possibly silver, lead, and thallium. Chlorides of thallium, sub-chlorides and sub-bromides of bismuth, and sulphides of copper, nickel, and cobalt show similar series of homogeneous substances.—J. **Grant** and J. R. **Partington**: Concentration cells in methyl alcohol. The E.M.F. of concentration cells formed from solutions of silver nitrate in methyl and ethyl alcohols as determined by Wilson agrees with that calculated from Nernst's formula only for the latter. Good agreement has been found, however, in both cases.—F. G. **Tryhorn** and S. C. **Blacktin**: The formation of anomalous Liesegang bands. Two examples of the production of anomalous Liesegang bands are cited in addition to the case of lead chromate in agar gels first noticed by Hatschek. The substances formed crystallise from the respective gels more readily in the light than in the dark.—J. B. **Firth**: Determination of the density of charcoal by displacement of liquids. It has been shown that the apparent densities of cocoanut shell charcoal and sugar charcoal have been determined after definite intervals, for several liquids. The values obtained increase with the time of contact between the liquid and the charcoal. Further, the final density value varies with the different liquids. It would appear that the rate of change in the density value and also the final density will be determined by the rate of sorption and sorptive capacity respectively.

EDINBURGH.

Royal Society, June 18.—Prof. F. O. Bower, president, in the chair.—F. **Walker**: The igneous geology of the Dalmeny district. The igneous rocks of the Dalmeny district may be divided into three groups:—(1) Basaltic lavas of Dalmeny type which are of undoubted Lower Carboniferous age. (2) A suite of sills which bear analcite and occasionally some nepheline. These sills are probably to be reckoned as the underground manifestation of Lower Carboniferous volcanic activity. (3) A group of quartz dolerite sills which belong to a later phase of intrusion and appear to be connected with Permo-Carboniferous earth movements. The second group contains some interesting petrographical types including teschenite, camptonite, and theralite. All three types are represented in the Mons Hill sill, which is of great complexity.—Miss Elizabeth **Gilchrist**: The slow oxidation of phosphorus. Phosphorus glows in air but not in oxygen at high pressures; some gases act as poisons while others act as promoters of the glow. The reaction appears to take place in two stages; phosphorus trioxide being produced in the first stage without glowing, and phosphorus pentoxide in the second stage with glowing. The hindering effect is ascribed to the production of an anticatalyst, which probably consists of negatively charged molecules.—G. A. **Carse** and D. **Jack**: On the X-ray corpuscular emission from iron in a magnetised and unmagnetised state. According to Ewing's theory of magnetism there is something in the iron atom that turns in response to an applied magnetic field. Experiments on the X-ray corpuscular emission from iron in a magnetised and unmagnetised state show that in the iron atom either the part that turns does not emit an appreciable number of electrons or the chance of ejection is not affected by the orientation.—Lancelot **Hogben**: The mechanism of amphibian colour response. The pituitary gland of mammals, birds, reptiles, amphibia, and fishes contains a substance which exercises a highly specific effect upon the melanophores of amphibia, inducing a condition of maximal expansion which is not precisely simulated by other drugs or tissue extracts, which agree in their action on plain muscle with pituitrine. The action of pituitary extract on melanophores is local and direct. Like other pituitary antacoids, the melanophore stimulant is destroyed by trypsin. Like the oxytoxic principle, it is more stable to acid hydrolysis than the pressor substance, and is mainly located in the posterior lobe of the fresh mammalian gland. After removal of the pituitary (whole gland) in both adult frogs and larval salamanders, the melanophores remain permanently in a state of maximal contraction, even when the animals are exposed to optimum conditions for producing pallor. When injected with pituitary extracts they expand fully; but the animals regain pallor even under exposure to those conditions which invariably produce melanophore expansion in normal or partially hyopohysectomised animals. The evidence for a direct nervous control of amphibian colour response is inadequate. Pituitary secretion fluctuates in correlation with conditions which evoke pigmentary change.

SHEFFIELD.

Society of Glass Technology (Leeds meeting), June 20.—W. E. S. **Turner**: Specifications in the glass industry. Certain types of glass, such as that used for optical purposes, are bought on specification and must conform strictly to certain properties. In the case of containers for liquids and solids, no attempt is made to manufacture or purchase on the basis of specification. If the glass industry insisted on furnace material makers providing, for example, refractories to specification, then the glass manufacturers themselves should at least show they are prepared to supply their own goods to specification. —Th. **Teisen**: Notes on the design of pot arches. Modern types should contain good facilities for heat distribution and control; they should also combine

good conditions for working and firing with easy installation and economy of space. In one type described, water is kept dripping on the firebars and on a plate arranged in front of them, thereby producing a certain amount of steam; this helps to retard the drying of the surface parts and allows the inside to evaporate its moisture at the same rate as the outside. This type takes up little space with proportionately less building cost, and results in practice are satisfactory.—S. **English**: Notes on the Ashley bottle machine. To one familiar only with modern glass-forming machines, it is surprising to learn that the home of bottle-making machinery is on this side of the Atlantic. The first machine to make narrow-mouth bottles at all satisfactorily was designed and built by H. M. Ashley at Ferrybridge (Yorkshire), about 1886.

PARIS.

Academy of Sciences, July 2.—M. Albin Haller in the chair.—Auguste **Béhal**: The fourth International Congress of Pure and Applied Chemistry. An account of the conference held at Cambridge on June 16-21.—Ch. **Gravier**: The adaptation to tree life of a Madagascan crab.—Henri **Villat**: A singular integral equation and a problem in the theory of vortices.—J. B. **Senderens**: The manufacture of ethyl and methyl ether. A study of the conditions (temperature and strength of sulphuric acid) for maximum yield of these ethers from their respective alcohols. For methyl ether, with sulphuric acid of the strength $H_2SO_4 \cdot 2H_2O$ and at a temperature of 160° C.-165° C., the ether can be made continuously at the rate of 250-300 c.c. per minute.—Bertrand **Gambier**: The curves of Bertrand and the deformation of quadrics.—Richard **Birkeland**: The resolution of algebraic equations by a sum of hypergeometric functions.—J. **Haag**: Certain particular states of a gaseous mass, agreeing with Maxwell's law.—A. **Lafay**: The arborescences traced out by the positive silent discharge.—Félix **Michaud**: The electrical properties of jellies. In an earlier communication the author showed that a jelly, when traversed by an electric current, contracts at the anode and swells at the cathode. From this it follows that a jelly submitted to a pressure gradient should show potential differences. This conclusion is verified experimentally.—F. **Wolfers**: The deviation of the X-rays at the surface of bodies, and the effects produced by a slit.—A. **Lepape** and A. **Dauvillier**: The fine structure of the limits of high-frequency absorption. The L limits of xenon.—M. **Marsat**: A combination of reflectors. An account of an optical arrangement of mirrors for use on motor cars, satisfying the condition that a beam should be cast at least 100 metres in front of the car, but with no dazzle at a height more than one metre from the ground.—Xavier **Waché**: Quantitative researches on the ultra-violet spectrum of copper in aluminium. With aluminium containing 5 per cent. of copper, 35 copper lines were photographed for wave-lengths between 2179 and 3274 international units. Alloys containing 1, 0·5, 0·2, 0·05, 0·01, and 0·005 per cent. of copper (in aluminium) were examined with the same Hilger spectrograph, and the gradual disappearance of the lines shown. For the 0·005 per cent. alloy only the two lines 3247·5 and 3273·9 remained.—A. **Marcelin**: The isothermal compression and expansion of superficial solutions. By superficial solutions is meant such systems as a monomolecular layer of oleic acid on water. Two forms of apparatus are described for measuring the changes in the surface tension.—M. **Holweck**: A helicoidal molecular pump. A description, with diagram, of a modified form of Gaede pump, with details of the results obtained by it.—E. **Carrière** and **Cerveau**: Determination of the boiling-point and dew-point curves of mixtures of hydrobromic acid and water under a pressure of 760 mm.—E. **Darmois**: Polarimetric observations on tartar emetic, and tartrate and malate of uranyl. The precipitation of antimony oxide from ordinary tartar emetic solution by the gradual addition of potash has been followed by means of the polarimeter. The first reaction is the precipitation of Sb_2O_3 and formation of potassium tartrate: beyond a certain point the addition of more potash leads to the formation of a new lævorotatory compound, not yet isolated. The same method applied to the study of uranyl tartrate and malate leads to the conclusion that complex acids resembling tartar emetic are formed.—Mme. N. **Demassieux**: The equilibrium between lead iodide and the iodides of potassium and ammonium in aqueous solution.—F. **Bourion** and E. **Rouyer**: The association of mercuric chloride. From a study of the rise of the boiling point of solutions of mercuric chloride of varying concentration, evidence of the existence of the molecule $(HgCl_2)_3$ has been obtained.—André **Job** and René **Reich**: The existence of organo-magnesium compounds containing arsenic.—L. **Hackspill** and G. **de Heeckeren**: A new volumetric method of elementary analysis. The organic compound is burnt with copper oxide in a silica tube *in vacuo*, the water formed condensed at − 80° C., and the carbon dioxide and nitrogen pumped out and analysed. The water is afterwards allowed to react with calcium hydride, and the hydrogen measured. In this way the whole operation is reduced to a gas analysis.—Paul **Woog**: The hydration of hydrocarbons. The carefully dried oils were allowed to take up moisture from moist air, and the amount of water taken up was measured by the resulting change in the electrical conductivity. Difference in the amounts of water taken up under these conditions was observed for different classes of oil.—F. **Ehrmann**: Discovery of evidence of the Tyrrhenide in the region west of Bougie (Algeria).—G. **Pontier**: The fossil elephants of England: the presence of *Elephas trogontherii* at the extreme base of the forest bed of Cromer.—Pierre **Dangeard**: Remarks on the state of the oil in the interior of oleaginous seeds.—L. **Blaringhem**: The mosaic of the sexes in a hybrid of wild sorrel (*Rumex Acetosa* × *R. scutatus*).—Emile **Haas**: Experiments on the states of regional and relative adaptation of the retina.—Emile **Devaux**: The pace of development in interfecundity.—A. **Pézard** and F. **Caridroit**: Gynandromorphism in the Gallinaceæ.—Anna **Drzewina** and Georges **Bohn**: Retarded effects of the dilution of the sperm on the development of the egg of the sea urchin.—Edouard **Chatton** and André **Lwoff**: The evolution of the Infusoria of the lamellibranchs. The primitive forms of the phylum of the thigmotrichs: the genus Thigmophrya.

Official Publications Received.

The Animal Products Research Foundation of the University of Adelaide. Second Annual Report, 1922. Pp. 6. (Adelaide.)

City and Guilds of London Institute. Report of the Council to the Members of the Institute, 1923. Pp. liii+89. (London: Gresham College.)

Sudan Government: Scientific Research Committee. Report of the Committee for the Year 1922. Pp. 9. (Khartoum: Sudan Printing Press.) 2 piastres; 5d.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Edited by W. F. Spear. Supplement to the Minutes of Proceedings of the Institution. New Series, No. 16, July. Pp. 219. (London: The Institution of Civil Engineers.)

Bishops Stortford College. Report of the Proceedings of the Natural History Society, 1922. Pp. 16. (Bishops Stortford.)

Technical College, Bradford, Diploma and Special Day Courses. Prospectus, Session 1923-24. Pp. 189+26 plates. (Bradford.)

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Prevention of Venereal Disease.

THE report of the Committee of Inquiry on Venereal Disease recently published[1] has been awaited with interest. It is a short report, as reports go, and it is an unanimous report, a result ardently desired by all those who have the matter at heart. The conflict of opinion on how best to root out venereal diseases from the community will still be remembered. It was voiced mainly by members of two societies, the National Council for Combating Venereal Disease and the Society for the Prevention of Venereal Disease, and was prominent both in the lay and medical press. The tone and publicity of the discussions seemed at the time regrettable, but it certainly aroused wide interest and helped to spread a knowledge of the main facts about the diseases, and in the end led to the calling together of this committee, the report of which, we believe, will give a fresh impetus to the attack on this world-wide infection. If the report should succeed further in uniting the fighting forces in this country, and make the two societies, which have in truth a common aim, join forces, this would be a crowning achievement. Both have expressed officially or otherwise their acceptance of the report. The co-operation of the two bodies would be so greatly for the good of the cause that we trust mutual goodwill will surmount any difficulties that remain.

The committee was a medical body appointed to consider the medical aspects of the subject under the chairmanship and vice-chairmanship of Lord Trevethin and Mr. Tomlin, K.C., respectively. Morals and medicine have always been liable to become entangled together, and on the subject of these diseases it is particularly difficult to avoid confusion in the public mind. The terms of reference to the committee made it very clear that the medical aspects only were to be considered. The terms were as follows:

"To consider and report upon the best medical measures for preventing venereal disease in the civil community, having regard to administrative practicability including cost."

The committee evidently realised that, in considering only medical measures for the prevention of venereal disease, it was not dealing with the whole problem of prevention. This is clearly set out at the beginning of the report—"having regard to the nature and origin of venereal disease the committee feel that . . . medical measures alone can never operate as an absolute preventive of disease, but their success must always depend largely upon the attitude towards them of the community and the co-operation of the community in securing their largest effect." How dependent a public

[1] Ministry of Health: Report of the Committee of Inquiry on Venereal Disease. Pp. 15. (London: H.M. Stationery Office, 1923.) 3*d*. net.

health authority is on public education and public co-operation for the effective control of any infectious disease was well demonstrated by the difficulties encountered in dealing with the recent smallpox epidemic at Gloucester, and yet smallpox is not usually a disease easy of concealment, there is no transgression of social standards implied in acquiring the disease, and it is of limited duration. All these facts should make it easy to control as contrasted with venereal diseases. In the latter, concealment is further aided by there being usually an absence of disablement from work; indeed, the symptoms may be so slight that the patient may be ignorant of being infected.

With these facts in mind, the conclusions of the committee on the question of notification of venereal diseases will, we think, meet with approval by the majority. The committee has reported against the introduction of notification in any form, on the grounds that as the disease can only become known to the doctor by a voluntary act on the part of the patient, concealment of disease is likely to follow notification, and it would prove a backward step. A modified form of notification, limited to those patients who, having presented themselves for treatment, failed to continue until cured, would impose a penalty on those who had at least shown some care for their health while letting the careless go scot-free. Another difficulty which is emphasised is the absence of any generally accepted standard of cure, and until this has been worked out, insistence under compulsion on a long course of treatment is wisely considered to be outside administrative practicability.

Turning to the controversial question of the *prevention* of disease by disinfection, either self-disinfection or skilled disinfection at the hands of a trained person, the committee agree that disinfectants do disinfect, given that the application is *thorough, prompt, and that the disinfectant is appropriate.* It stresses the fact that, to a large extent, exposure to infection takes place under conditions in which neither promptness nor thoroughness are likely to be exercised, and that the success of any public facilities for self-disinfection in the civil community is likely to be very small. But though in the opinion of the committee the majority would fail, a minority should succeed, and no obstacle should be placed in the way of private purchase of appropriate disinfectants. The law does not to-day permit the sale of *ad hoc* disinfectants. In order to obtain them the public must have either a doctor's prescription or be able to ask for what it wants by the exact name. The report advises the alteration of the law to allow of the sale of disinfectants in an approved form, with instructions for use approved by some competent authority. The suggestion that the Medical Research Council should be invited to undertake this task will, we hope, be received favourably. That body is already responsible for the standardisation of the arsenical compounds used in the treatment of syphilis, and its authoritative and independent position would make it particularly suitable for this undertaking. It is specifically advised that the commercial advertisement of such disinfectant should be prohibited. The importance of self-disinfection will find expression first among the educated classes, and from these will penetrate, as temperance did, into the minds of the community as a whole.

The general application of a system of skilled disinfection, which would necessitate the establishment and maintenance of buildings and also of attendants, is dismissed on the grounds of impracticability and cost, but in a later paragraph the committee shows an appreciation of the value of an experiment such as was made at the Manchester Ablution centres, and suggests that local authorities should be assisted to carry out experimental schemes for the prevention of venereal diseases, as for example in dock areas, where local conditions demand special measures. This, we think, is an excellent method of gaining administrative experience and of educating the public. It has already received official sanction in the past, and we hope that energetic local authorities will take advantage of the suggestion.

In addition, however, to medical measures for preventing disease in, or minimising the risk of disease to, persons exposed to infection, there are those for rendering non-infective, and curing, diseased persons. With regard to the latter, the committee remarks that

> "speaking generally, the general medical practitioner is not yet adequately equipped with the most advanced knowledge of venereal diseases and their treatment to enable him to deal competently with all the cases that come before him, and that an improvement in medical education in regard to venereal disease is necessary."

The present clinic system receives a full measure of approval, and extension and improvements are asked for. The importance of the educative work that is done in the clinic is stressed. The actual sufferer from the disease is almost the most important person to teach where limitation of the spread of disease depends so greatly on voluntary individual action. The doctor's words will always carry most weight with the patient, and we believe that most medical officers of clinics realise this and carry out this part of their work with self-sacrificing devotion; but patients may be stupid and ignorant and need often repeated explanations, the doctor's time and endurance are limited. Printed instructions and warnings are less impressive than the spoken word. The recommendation that trained social workers should be attached to the staff of clinics

to give supplementary teaching as well as general advice and assistance will, we hope, receive attention. We think that this is one of the most important of the recommendations. It is, in fact, no new departure, but at present the need for such work is not generally realised, and the number of clinics to which workers are attached is limited.

The work of ante-natal clinics is strongly commended. The position to-day as regards congenital syphilis is extremely encouraging. It seems within the bounds of possibility that inherited syphilis may cease to exist some day, so effective is the treatment of the syphilitic mother during pregnancy in securing a healthy baby, though sufficient time has not yet elapsed since the beginning of ante-natal treatment for any one to say that so insidious a disease as syphilis can be wiped out with certainty in every case.

A short paragraph summarily directs attention to three sources of disease which need tackling, although they present serious administrative problems. The three sources mentioned are infected immigrants, infected seamen, and infected mental defectives. The matter of arrangements for the treatment of infected seamen has already received much attention, but more remains to be done. The adequate care of the slightly feeble-minded and infected individual is of great importance to the community; as a focus of infection he or she may do an infinite amount of harm. No amount of teaching will develop a sense of responsibility, and temporary or permanent control is necessary.

The report shows us, in conclusion, how best to lay out our limited public money: first, in the treatment of disease; secondly, in teaching the public about the diseases; thirdly, in improvement of the conditions of living, *i.e.* houses, general education, and facilities for healthy recreation. It ends by directing attention to the decline in the numbers of sufferers from venereal diseases as shown by the clinic figures during the last two years. As, however, these still show an enormous prevalence of disease, no relaxation of effort can be allowed. The work of education on the subject of disease is, moreover, one that must be continued for all time. We cannot hope that venereal diseases will ever cease to exist, and their control will always depend on the enlightenment of the public. It is to be hoped that this report, issued at the very low price of 3*d*., will be widely read, for it concerns a subject of world-wide importance, and any summary discussion must necessarily leave untouched many important points with which it deals.

Lord Dawson, through whose efforts the committee and consequently this report came into being, is to be congratulated on the performance of a valuable public service.

Physics and its Applications.

A Dictionary of Applied Physics. Edited by Sir Richard Glazebrook. In 5 vols. Vol. 4: Light—Sound—Radiology. Pp. viii + 914. (London: Macmillan and Co., Ltd., 1923.) 63*s*. net.

THERE was a time, not so very long ago, when the student of physics could reach down from his shelves "Ganot" or "Deschanel" and, "laying flattering unction to his soul," could proceed to master their contents with the comforting if misguided assurance that here all useful knowledge was displayed. No such vanity of outlook is possible to the present-day student. The physics of this generation is teeming with such vitality, is making such gigantic strides and devouring at such a pace the boundaries of its sister sciences, that it threatens to overwhelm those of its devotees who vainly seek to achieve an all-round distinction.

The full truth of this is patent to the reader (and reviewer) who has attempted to survey the amazing compendium of knowledge in the various volumes of the "Dictionary of Applied Physics" which have been issued under Sir Richard Glazebrook's editorship. The Dictionary has become, as it was bound to become, a pillar of physical science and a fascinating mine of information, indispensable alike to the teacher, student, and investigator. One had been tempted to wonder whether the high standard set in the earlier volumes could be sustained, but a critical survey of the latest new-comer is amply reassuring. Sir Richard goes on, in fact, from triumph to triumph. Volume 4, which is devoted to light, sound, and radiology, shares in common with its predecessors a clarity, vigour, and "first-handedness" which are characteristic only of the investigator who is in close contact with his subject and endowed with the art of expounding it.

By far the greater part of the present volume is occupied with optical subjects. The first article is one by Dr. A. E. H. Tutton, who gives a short account of crystallography dealing, *inter alia*, with a number of ingenious instruments of his own design which have been employed in his extensive and well-known researches. Dr. John A. Anderson, of the Mount Wilson Observatory, refers briefly to the manufacture and testing of diffraction gratings. One learns that the general impression which prevails that the construction of a successful ruling machine is bound up with the manufacture of a perfect screw is erroneous. It is not difficult to make screws uniformly accurate to $\frac{1}{100,000}$ inch, but much more difficult to avoid errors due to faulty mounting. "The Theory of Diffraction Gratings," by Mr. J. Guild, of the National Physical Laboratory, forms a succinct though abbreviated companion article to Dr. Anderson's. Mr. Guild is

also responsible for an excellent summary of the physics of the human eye.

Several articles on glass follow, written from different points of view by Mr. E. A. Coad-Pryor, Mr. W. H. Withey, and the late Mr. Harry J. Powell. Mr. J. Rheinberg discourses on graticules and platinised glass; and the Paterson-Walsh height-finder, which found application in anti-aircraft work in the War, is described by Mr. J. W. T. Walsh.

Dr. W. W. Coblentz, of the Bureau of Standards, Washington, writes briefly on infra-red transmission and refraction data and includes a number of useful tables. An article on the kinematograph by Dr. J. W. French sets out in interesting fashion the main physical points which have had to be dealt with in bringing the instrument to its present state of development. Light filters are discussed by Dr. C. E. Kenneth Mees, and magnetic rotatory power by Prof. T. M. Lowry.

A long article on the optics of the microscope by Prof. A. E. Conrady deals comprehensively with a subject which normally receives inadequate attention. There is a wide gap between the optics of the text-book and that of the practical optician, and here we find the gap bridged by an acknowledged authority. Microscopy with ultra-violet light, and the enhanced resolution that it effects, are the subject of a very interesting article by Mr. J. E. Barnard.

Commander T. Y. Baker sets out in a noteworthy contribution the main underlying facts of navigation and navigational instruments. The mathematics of the Sperry gyroscopic compass are given, and the author makes reference to the atmospheric difficulties relating to the use of directional wireless. At times there appear to be long tracks in the atmosphere offering preferential facilities for the transmission of wireless waves, while at sunrise and sunset marked deviations may occur, directional errors of 20° or more being of frequent occurrence.

Mr. J. H. Sutcliffe unveils the mysteries of the specialised technique of ophthalmic optical apparatus. An article on optical calculations follows, by Mr. T. Smith, of the National Physical Laboratory, who, in association with Dr. J. S. Anderson, writes also on optical glass, including in the article a wealth of numerical data. The working of optical parts by Dr. J. W. French is a contribution of great practical interest, while Mr. T. Smith's very readable monograph on periscopes contains information much of which we imagine must here be set out for the first time. A lengthy and authoritative article by Mr. J. W. T. Walsh on photometry and illumination is notably up-to-date, and describes in detail the precision methods in use at the National Physical Laboratory and elsewhere. Photographic apparatus is treated very completely by Mr. C. W. Gamble, though the section on the modern development of aerial cameras calls for lengthier notice. Photographic lenses are dealt with by Mr. T. Smith.

Prof. C. G. Darwin sums up very briefly the present position of the quantum and radiation theories in physics, and this is followed very appropriately by Dr. W. W. Coblentz's admirable discussion of radiation from a practical point of view.

Two useful contributions on radioactivity and radium by Dr. E. A. Owen might advantageously have been permitted a lengthier treatment. The radium testing-work of the National Physical Laboratory has been of vital importance to the radium market in Great Britain, and we find the methods of test fully set out here. An article on radiology deals largely with the industrial developments of X-rays and the work of the National Physical Laboratory on X-ray protection.

The supreme importance of the short-base range-finder in the War needs no emphasis here. It forms the subject of an arresting contribution by Prof. F. J. Cheshire. The fighting services in Great Britain have favoured the "coincidence" type of range-finder, while the Germans employed the Zeiss "stereoscopic" pattern. In the laboratory there appears to be little in it as regards the two types, but under service conditions it is easier to train men to get accuracy with the coincidence type, an advantage which is emphasised when an operator is working under the intense nervous strain induced by modern warfare. The battle of Jutland permitted a comparison between the two types with almost identical base lines; and on a balance of evidence the coincidence type must, Prof. Cheshire states, be given first place.

Lord Rayleigh writes on the scattering of light by gases, a subject with which his name and that of the late Lord Rayleigh have noteworthy association.

Prof. E. H. Barton has a long and interesting article on sound and musical instruments in which is included a good, if somewhat brief, discussion of the question of the acoustics of buildings, a subject which is greatly to the fore at present, and is now receiving attention at the National Physical Laboratory and elsewhere. Attention is directed to the investigations of Webster, and in particular of the late Prof. Sabine in the United States, work which is not sufficiently known in Great Britain. We cannot afford to have many repetitions of the new County Hall of London acoustical fiasco. Prof. W. L. Bragg touches briefly on sound ranging, a branch of military activity in which, thanks largely to the Tucker hot-wire microphone, we enjoyed conspicuous advantage in France during the War.

Dr. T. R. Merton writes authoritatively on modern spectroscopy. A very informative article on spectroscopes and refractometers by Mr. J. Guild includes

a detailed account of the new National Physical Laboratory standard spectrometer. Spectrophotometry forms the subject of another article by Dr. K. S. Gibson, of the Bureau of Standards.

Major E. O. Henrici deals with spirit-levels and surveying. A recent development which does not find a place is the shaping of the level-tube so that the length of the bubble becomes independent of temperature changes. Prof. Horace Lamb contributes a short note on the vibrations of strings.

Prof. R. A. Sampson, Mr. T. Smith, and Dr. J. S. Anderson give between them an excellent and up-to-date treatment of telescopes, while Sir Richard Glazebrook himself is responsible for a number of short articles on optics. The volume concludes with an uninitialled contribution dealing comprehensively with the measurement of wave-lengths, which we gather from the list of contributors is by Dr. W. F. Meggers, of the Bureau of Standards. Dr. Meggers brings out in a useful summary table the striking fact that the range of electromagnetic waves known to science extends to more than 40 octaves, from the gamma rays of radium on one hand to the wireless and "electric" waves on the other. Since this article was written the gap of four or five octaves between ultra-violet and X-rays has been bridged, and now the only unexplored interval is one of two octaves between the infra-red and wireless waves.

We have perforce had to omit mention of many excellent contributions, but the reader will perhaps discern from what we have cited the quality of the fare that is set before him.

In conclusion, we consider that the substantial weight of the various volumes lends support to the view that they could advantageously be divided into two. We wonder, too, whether the "dictionary" mode of interpolating headings in alphabetical sequence between the various articles has much to justify it. Each volume is provided with an excellent index which could readily be made to serve every requirement, and will normally be the first resort of any reader seeking information.

G. W. C. KAYE.

The Thermal Decomposition of Wood.

The Destructive Distillation of Wood. By H. M. Bunbury. Pp. xx+320. (London: Benn Bros., Ltd., 1923.) 35*s.* net.

ONE hundred and fifty million tons of "wood waste" are produced annually, most of which, it is claimed, finds no useful application. Possible methods for the utilisation of this material are its destructive distillation to give valuable products, its employment directly as a fuel, its use in paper production, or its fermentation to produce ethyl alcohol. The first application, and wood distillation generally, although forming the subject of an ancient industry, has not hitherto been taken as the sole title of an English text-book. On account of the important economic problem involved the author has much to justify his effort, and from many points of view his book is a success. The descriptions of plant and processes for wood distillation and of stills and evaporators employed in the recovery of the distillation products are lucid, and while technical details have been considered, exactness in statement has been maintained.

From an economic point of view the efficient working-up of the products of distillation is all-important, and naturally this problem has received careful attention. The works chemist is confronted, among other problems, with the isolation of various organic compounds from his crude liquor condensate obtained when wood is destructively distilled. This heterogeneous product contains, in aqueous solution, acids, bases, alcohols, aldehydes, ketones and other substances, and in suspension, tarry matter of a highly complex composition. The author enumerates more than sixty compounds generally present, in addition to many others found in the crude oil from soft wood distillation. On distillation, after the acid products are fixed, various azeotropic mixtures, both binary and ternary, are formed, which makes the isolation of the individual compounds difficult.

The observations of Guillaume and Sorel on the purification of alcoholic liquors generally by a steam distillation method are not referred to, but developments from these researches are considered in detail, particularly in regard to the production of pure methyl alcohol direct from crude wood spirit.

Wade and Merriman in their classical work on constant boiling-point mixtures adopt the term azeotropic for such mixtures instead of hylotropic as proposed by Ostwald. Young and Lecat also prefer the word azeotropic with its more defined meaning. It is therefore to be regretted that in this volume the older term is again introduced. The author writes of a particular hylotropic mixture of 90 parts by weight of acetone, and 10 parts by weight of methyl alcohol, and later refers to this mixture as the "pure" or "theoretical" methyl acetone.

The author has given numerous flow sheets, but these, it is hoped, may be developed in a future edition, if possible on more quantitative lines. In the technical records of the Ministry of Munitions the idea of flow sheets and flow diagrams, not only qualitative but also quantitative, have been emphasised, and should set a standard.

The analytical methods are condensed into a dozen

pages, and offer no novel features. Owing to the drastic condensation employed, difficulties may occur in endeavouring to follow the directions. The alkalinity test for refined methyl alcohol is on the line of the Government "methyl orange alkalinity test" for wood naphtha for use as a denaturant, though this is not stated. In the abstracted form in which the test is described it may be misleading if applied generally.

The separate treatment of physical properties is a welcome feature in a technical volume of this type. The scope, however, is restricted, density and humidity only receiving consideration. The factor of wind velocity as an influence on humidity has not been indicated. More accurate practical means of measuring humidity (*e.g.* Assmann's hygrometer) are available than that described. The main source of reference appears to be the publications of the United States Forest Service.

On the assumption that wood cellulose first forms lævoglucosan on distillation, the author indicates how the two rings in this carbohydrate might be broken up to give many of the usual products obtained on the industrial plant. Pictet, however, obtained his lævoglucosan from a pure cotton cellulose, while it has yet to be shown that the cellulose from broadleaf or conifer trees will give appreciable amounts of lævoglucosan even on vacuum distillation. It must be recognised also that the non-cellulose portion of the wood has a profound influence on the nature of the decomposition. The author states that "it is now established that the complex carbohydrates found in plants are produced in the first place from formaldehyde which is photosynthesised in the leaves from CO_2 and water," and two references are given to the work of Baly and Heilbron. Possibly the word *established* is too strong at this stage in the chemistry of plant structure. The chemistry of wood is restricted to eighteen pages, and of necessity is incomplete. Two structural formulæ proposed by Irvine for cotton cellulose are given, but it is not made clear that even the resistant cellulose in wood has yet to be shown to be of similar constitution. Indication should be made to the fact that Irvine obtained his 2 : 3 : 6 trimethyl glucose from the highly methylated cellulose by hydrolysis.

It is stated that charcoals can be represented as $C_{16}H_{10}O_2$, and in a footnote it is implied that the formula is not intended to represent a single chemical compound. Again, in another connexion $C_{10}H_5O$ is indicated to be "primary charcoal," and $C_{30}H_{20}O_3$ to be "secondary charcoal." Giving definite molecular formulæ, rather than percentage composition only, to these residual products is not considered sound in the present state of our knowledge.

Charcoal was originally the main product sought after in wood distillation for metallurgical needs, but a substitute has been found in coke. Acetic acid and methyl alcohol are now the principal products desired. Organic and biological chemistry are, however, making rapid strides, and soon these products may possibly be produced more cheaply by processes other than the thermal decomposition of wood. The gases once considered unimportant may yet become the mainstay of the wood distillation process. The outlook, however, at present is not very hopeful, at least in coal-producing countries. Recent developments, which are very well described by the author, have been along two lines—the carbonising of wood in gas retorts and in gas producers or generators.

The text shows the mark of careful editing, and only a few errors and misprints have been noticed. In some instances a lack of uniformity in units occurs. Again, such statements as "Add H_2O_2 to decompose the remaining $KMnO_4$," or "1 gram $CO_2 = 1.045$ grams of H.COOH," might be expressed otherwise. There is too great a tendency to use molecular formulæ as a kind of shorthand in the text.

The volume is more in the nature of a well-written compilation of current literature than a record of the author's personal experiences. It contains one hundred and twenty tables, many of them full-page, as well as more than a hundred illustrations and photographs all excellently reproduced. In the printing and arrangement of the book there is little further to be desired. The only serious complaint that can be offered is that the price tends to restrict the book to the reference library rather than to place it on the shelves of the industrial chemist and technical student, where it would be extremely useful.

JOSEPH REILLY.

Clinical Pathology.

A Manual of Clinical Diagnosis by Means of Laboratory Methods, for Students, Hospital Physicians and Practitioners. By Dr. Charles E. Simon. Tenth edition, enlarged and thoroughly revised. Pp. xxiv + 1125 + 23 plates. (London: Henry Kimpton, 1922.) 42*s.* net.

IN any branch of knowledge actively progressing in many divergent directions it is of course difficult to keep the whole field of investigation in proper perspective, and the very keenness of the workers in the different divisions tends to keep them immersed and somewhat solitary in their own grooves. This disadvantage specially concerns medicine, in which it is most desirable that the clinicians and the laboratory workers should be in close and constant touch with each other; to some extent this is effected by clinical pathology, and the clinical pathologist

should be the equal and companion of the clinical physician. One of the deservedly best known text-books on this important subject is Dr. Charles E. Simon's, first published in 1896, the tenth edition of which is now before us. During its life of more than a quarter of a century, it has served as a kind of index of the extent of the subject, and in this connexion it may be noted that the present edition is more than double the size of the first. Dr. Simon, who speaks with the authority of a former professor of clinical pathology, a post he has given up for that of lecturer in medical zoology in the School of Hygiene and Public Health of the Johns Hopkins University, Baltimore, is emphatic in his opinion that even now too little attention is paid to clinical pathology by hospital physicians, and that accordingly students and general practitioners are without an accurate idea of the value of this means of diagnosis. Dr. Simon advocates the establishment in every medical school of a chair of clinical pathology, and that its occupant should in every respect rank equally with the clinical teachers.

The subject matter of clinical pathology is so constantly increasing that, as the author admits, it is impossible for a text-book to be actually up-to-date. The truth of this is indeed shown in this instance, for the date of its going to press is apparently June 1922, and there is not any reference to Hijmans van den Bergh's test for bilirubins in the blood serum, now much employed in the differentiation of obstructive from other forms of jaundice, which was first brought prominently to the notice of British readers by Dr. J. W. M'Nee's paper in the *British Medical Journal* of May 6, 1922.

The present edition has 273 pages more than its predecessor, and has been largely rewritten, especially the section on parasitology, which now occupies more than 100 pages and is illustrated by fifty figures.

The subject of the blood takes up more than a fourth part of the volume, and, naturally from the great interest taken in America in the subject of basal metabolism, gives the methods of estimating the hydrogen-ion concentration of the plasma, the determination of the carbon dioxide combining power of the plasma, and the determination of the alveolar carbon dioxide tension. The estimation of the blood sugar and the tests for renal efficiency have been brought up-to-date, though perhaps more might have been said about the lævulose test in connexion with hepatic insufficiency. The serological section has been entirely rewritten, and the author's method of carrying out the Wassermann reaction for syphilis is fully detailed and critically compared with that of Noguchi. It may be noted that in the section on parasites, under the heading of Leptospiras, the genus isolated by Noguchi, the organisms of spirochætosis icterohæmorrhagica and of yellow fever are described with a plate.

The section devoted to the alimentary canal contains a good account of Rehfuss's fractional analysis of the stomach contents, which gives an insight into the entire cycle of gastric digestion, including both the secretory and the motor activities of the viscus. Lyon's method of obtaining bile by means of the duodenal tube is described, but the recent discussion on the validity of the distinction of the three categories of bile—from the common bile duct, the gall bladder, and the liver—obtained by this procedure is not mentioned.

In the second part of the work, occupying about one-quarter of its pages, the diseases are arranged in alphabetical order with the essential points in their laboratory diagnosis. In conclusion, this manual may be confidently recommended to clinical pathologists as a valuable source for daily reference.

Argumentum ad Communem Sensum.

Universe. By Scudder Klyce. With Three Introductions by David Starr Jordan, Prof. John Dewey, and Morris Llewellyn Cooke. Pp. x+251. (Winchester, Mass.: The Author, 1921.) 10*s*.

WE are told on the highest authority that there are things which God has hidden from the wise and prudent and revealed unto babes. The extraordinary claim which Mr. Klyce makes in this book is that the whole riddle of the universe has a verifiable solution which can be made plain to a child of six. Quantitatively indeed, the child might find this book an overdose, but qualitatively it would understand the argument. The author speaks from knowledge, for he tells us he has tried it and found it is so. The preliminary prospectus is so extravagant, and the account of the conception and production of the book (which we are told was rejected by eighteen publishers and turned down by twenty-five financiers, and consequently had to be printed by the author in a press set up by himself for the purpose) is so amusingly naïve that the serious student would probably decide on *a priori* grounds that its value is zero, were he not arrested by the names of three distinguished scholars who have made themselves sponsors for the author and his work. Two of them, Prof. J. Dewey and Dr. David Starr Jordan, enjoy a world-wide reputation. We are compelled, therefore, to treat Mr. Klyce's book seriously.

The first distinction to which we are introduced is that between qualitative and quantitative problems. It is the former which are easily solved: the latter are infinite in number, and as life is finite we cannot exhaust them. It is in regard to the qualitative problems in religion, science, and philosophy, that Mr. Klyce thinks we are being fooled by a trick of language, for

this in his view is what "logic," which he opposes to "commonsense," is. Get behind language, behind the sign which merely serves the purpose of a finger-post, to the thing signified, and the problem disappears. We call to mind that Descartes said, "Give me matter and movement and I will make the world." But we also remember Pascal's remark concerning it, "Quand cela serait vrai, nous n'estimons pas que toute la philosophie vaille une heure de peine."

Mr. Klyce divides his task into three parts. Let us leave the philosophy and religion and attend only to the concrete science. The principle and method are the same in all three parts. All difficulties turn out to be a "trick of language," and, when this is exposed, the sophistication is obvious and the truth becomes dull in its very obviousness. When we come to the definite treatment of mathematics and physics the problems prove to be variations of the single problem of the One and the Many. It is not easy to give a clear example, notwithstanding the claim of lucidity, because the text is so laden with diffuse parenthetical remarks. Some notion of the principle may be gained, however, if we reproduce *verbatim* a few sentences from the treatment of Newton's three laws of movement, with which Part II. on Physical Science begins. "Clearly his first law is substantially equivalent to what we started with in formulating language—the verbal meaning of a One which we may arbitrarily divide. It is equivalent in detail to: *all* matter (the One), as such, has the 'property' of *not* changing. And that is no 'property' at all, but an assertion that 'all matter' is *not-divided*—which is a verbal truism at the beginning of monotheistic speech." And this: "It may be reasonably held that his first law is an assertion of or agreement to use God the Father or One words. The second law, then, is a statement of God the Holy Ghost, or 'force.' And we shall see that the third is explicit statement of God the Son."

The book covers very complete ground, and the author shows that he is acquainted with the modern mathematical and physical theories which he discusses in the above manner. There is a certain puzzling inconsistency, however, in finding in logic the principle of "unification" and then condemning logic as a trick. But whether or not readers are convinced by the author's argument, they cannot fail to be interested in the psychology of the author himself which it reveals. Yet it can scarcely have been this which has led Prof. Dewey to write the prologue. Mr. Klyce would render an inestimable service to philosophy if he would persuade Prof. Dewey to add an epilogue; for his prologue leaves us in some doubt as to whether he himself has verified this verifiable solution of the riddle of the universe.

Our Bookshelf.

The Study of English Speech by New Methods of Phonetic Investigation. By Dr. E. W. Scripture. (Published for the British Academy.) Pp. 31. (London: Oxford University Press, 1923.) 3s. 6d. net.

DR. E. W. SCRIPTURE's memoir deals with the employment of instruments and apparatus which "not only record the facts of speech automatically and permanently, but also provide for interpreting them with microscopic accuracy," and discusses a number of linguistic problems which have been or might be approached by these means. Philologists are divided more or less into two camps by the assertions of Prof. Sievers, of Leipzig, as to the intonation of ancient Hebrew, Greek, Swedish, Gothic, etc. Rejected by some as having no objective basis, his inferences are accepted by others as authoritative, and are now finding their way into the text-books, as in Streitberg's "Gotisches Elementarbuch." Meanwhile the number of phonetic laboratories on the continent is increasing. There are workers in this field in Paris, Hamburg, Prague, Uppsala, Utrecht, Louvain, Kristiania, and other places.

The recent correspondence on Shakespeare's Verse in *The Times Literary Supplement* (closured April 26) shows how attractive such problems of analysis can be to those who like to work at something difficult, and suggests the need of concentration. It is difficult to believe that Shakespeare's lines have ever been more admirably delivered than by Sir J. Forbes-Robertson. A gramophone record allows those prosodists who judge by ear to revise their impressions indefinitely, while a mechanical enlargement of the curves on the disc permits the metrical proportions of duration, amplitude, and frequency to be measured to a high degree of exactness, at the cost, certainly, of much highly skilled labour.

Théorie mathématique des phénomènes thermiques produits par la radiation solaire. Par Prof. M. Milankovitch. Pp. xvi+339. (Paris: Gauthier-Villars et Cie, 1920.) 20 francs net.

THE earlier chapters of this work are concerned with finding formulæ for the amount of "insolation" or reception of radiation from the sun at various latitudes on planets, first without atmospheres, and secondly with them. The formulæ involve the reflective power of the planetary surfaces; the propagation of heat-waves in the soil and the effects of change of obliquity and eccentricity of orbit are also considered. It is pointed out that a rapid rotation diminishes the difference between diurnal and nocturnal temperatures while slow rotation increases it.

The second part of the book applies the formulæ obtained to the case of the four inner planets and the moon. For the earth the author discusses secular changes of climate depending on changes of obliquity and eccentricity, and regards Croll's theory as still tenable, being thus in opposition to most recent climatologists.

Prof. Milankovitch concludes that the thin air on Mars allows a considerable amount of heat to reach the soil by day, but that the nights are intensely cold.

Mercury and the moon are concluded to suffer from great extremes of climate, while the high albedo of Venus indicates that much light and heat is reflected without reaching the surface, so that the temperature of the latter may be moderate. A. C. D. C.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. E. Abderhalden. Lieferung 94. Abt. IX: Methoden zur Erforschung der Leistung des tierischen Organismus. Teil 1, Heft 3: Methoden der zoologischen Forschung. Pp. 439-584. (Berlin und Wien: Urban und Schwarzenberg, 1923.) 6.3 Schw. francs.

THE present number of this extensive work is devoted to methods of zoological investigation. The first article, by L. Neumayer, deals with the fixation of tissues for histological purposes, and provides a useful, well-arranged account of the various fixatives, with notes on the different tissues to which they are applicable. There are also abundant references to the literature of the subject. The second article deals with entomological technique, and is contributed by Albert Koch. In this account are included descriptions of all the various entomological methods of collecting and mounting specimens, rearing larvæ, and the preparation of material for histological study. The third article, by W. A. Collier, deals with the determination of age in fishes by means of growth phenomena afforded by the otoliths, opercular bones, and scales.

The last article is by Th. Mollison, and treats of serum diagnosis as a test of affinities as applied to zoology and anthropology. Previous parts of this work have already received notice in our columns, and the present contribution is no exception to the general standard of excellence that characterises this encyclopædic treatise.

La Lampe à trois électrodes. Par Prof. C. Gutton. (Recueil des Conférences-Rapports de Documentation sur la Physique. Vol. 5, 1re Série, Conférences 11, 12, 13. Édité par la Société *Journal de Physique.*) Pp. 181. (Paris: Les Presses universitaires de France, 1923.) 15 francs.

RADIO engineers will welcome this book by Prof. Gutton. He starts by giving a complete account of the physical phenomena utilised in the three terminal thermionic valve. Full use is made of characteristic curves, and formulæ given by Richardson, Langmuir, and Clerk Maxwell are quoted. In the second chapter several good types of apparatus suitable for amplifying are described and approximate formulæ are obtained for them. In the next chapter oscillating circuits are given, the theory being well and clearly explained. The theory of the methods of using filters to eliminate harmonics is also given. Next comes the theory of detectors and detecting circuits. Finally the arrangement to get "negative resistance" is shown and the methods of obtaining high frequency currents by utilising suitable valves are described and their useful applications in making electric measurements are explained. The author defines the resistance of a circuit as "negative" when an infinitesimal reduction of the terminal voltage produces an infinitesimal increase in the current.

Biologie der Tiere Deutschlands. Bearbeitet unter Mitwirkung zahlreicher Fachleute und herausgegeben von Dr. Paul Schulze. Lieferung 1. Teil 2: Spongiaria. Von P. Schulze. Teil 3: Cnidaria. Von P. Schulze. (Berlin: Gebrüder Borntraeger, 1922.)

THIS is the first of a series of booklets giving an account of the general biology, physiology, life history, and ecology of the animals comprising the German fauna. Marine forms are omitted from considerations of space. No systematic treatment is attempted, and only so much of the anatomy, histology, and embryology of the animals is included as is necessary for a proper understanding of their biology. It is essentially a book of Nature study, wholly excellent in conception, popular in intention and strictly scientific in treatment. It will be issued in a series of pocket volumes, on the lines of Brauer's "Süsswasserfauna," and when completed will form a companion work to Brohmer's "Fauna von Deutschland," in which the systematics of the groups are dealt with. The work is intended for use in the field by students, teachers, and field naturalists generally, and should be of the greatest value in stimulating the study of Nature on a scientific basis. There is room for a similar work on the British land and freshwater fauna; but until such appears this book will, at any rate partially, fill the need.

The Common Birds of India. Described by Douglas Dewar and illustrated by G. A. Levett-Yeats. Vol. 1. The Sportsman's Birds, Wild Fowl, Game Birds, and Pigeons. Part I. Pp. viii+44. (Calcutta and Simla: Thacker, Spink and Co., 1923.) Rs. 2.8.

MR. DEWAR contemplates a series of volumes (five in all, of about 140 pages each) dealing with the birds of India as a whole and forming a profusely illustrated work of a popular nature designed for the guidance of sportsmen and the non-scientific resident. The first part deals with the ducks, swans, and geese, and though the style is too journalistic, the matter is excellent as a good account of the salient features of these birds and of their general natural history. A list of vernacular names and an easily used key for ready identification are two features of special value which we hope will be continued in later volumes. Mr. Levett-Yeats's illustrations add considerably to the usefulness of the work and are worth the expenditure of a little more care in reproduction. There is room for this book, and we hope that Mr. Dewar will receive sufficient support to justify him in carrying the project to completion.

La Vie des atomes. Par Prof. A. Boutaric. (Bibliothèque de Philosophie scientifique.) Pp. 248+4 planches. (Paris: E. Flammarion, 1923.) 7.50 francs net.

PROF. BOUTARIC deals in an interesting way with the recent advances in physics which led to the present view of the structure of the atom. The last part of the subject is treated only very briefly, but the fundamental experiments are clearly reviewed. The treatment is non-mathematical, and the book will be read with interest by those who wish to obtain some conception of the radical changes in outlook which have resulted from recent work. There is no index.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Mass-spectrum of Copper.

THE number of elements of which the isotopic nature has been determined is now large enough to give considerable weight to statistical relations. Among elements of odd atomic number two definite empirical rules stand out. The first is that none of them consists of more than two isotopes. This has no exception so far. The second is that the more abundant of the two constituents, or both, will be of odd atomic weight. The only exception to this is the element nitrogen; moreover, the only even isotopes at all are the weaker constituents of lithium and boron. That both of these rules should be violated by copper having the three isotopes 62, 64, 66, announced recently by Prof. Dempster, seemed therefore excessively improbable.

I have now been able to obtain the mass-spectrum of copper by employing cuprous chloride in the accelerated anode ray method used with the mass-spectrograph. The lines are faint, but their evidence is conclusive since they appear at the expected positions 63 and 65 and have the intensity ratio, about 2.5 to 1, predicted from the chemical atomic weight 63.57. The positions of the lines could be determined with great accuracy by comparison with the line 56 due to iron derived from the anode container. No deviation from the whole number rule was observed.

With regard to Prof. Dempster's results (NATURE, July 7, p. 7), it is very suggestive that the intensity and grouping of the lines he ascribes to copper agree exactly with those of the strong isotopes of zinc. It seems possible, therefore, that they are due to the presence of traces of that element either in the copper or more probably, together with the rubidium he mentions, in the furnace material.

F. W. ASTON.

Cavendish Laboratory, Cambridge, July 25.

Polar Temperatures and Coal Measures.

FOR some years I have held a view of the possible origin of some at least of the coal measures of the polar regions that is not found in the ordinary geological text-books. After discussing it with a dozen friends who are geologists, and some of them specialists in glacial geology, I have concluded—somewhat to my surprise—that the theory is new. A short statement of the theory may therefore be desirable.

It is generally considered that certain plants are not limited in their geographic range, by no matter how intense a cold in winter, if only they have an adequately hot summer. Apparently this hot summer may be very short and still the plants prosper. Notable examples are the black spruce of northern Canada and similar trees in the northern part of the Old World.

In the western hemisphere I have examined specimens of coal from 79° north latitude. So far as the material could be identified it was coniferous. In other deposits almost equally far north I have found gum and pine cones.

The northern limit of conifers in North America at present is between 68° and 69° north latitude. That this limit is determined not by intensity of cold in winter, but by lack of heat in summer, is shown by the luxuriance of the black spruce and several other trees in the mountain valleys of the Yukon, where the minimum temperatures in winter are from 10° to 20° lower than at the northern limit of trees. This northern limit is therefore determined by the proximity of the Arctic waters chilled by floating ice, which lower the summer temperature.

The United States Weather Bureau frequently reports temperatures above 90° in the shade, observed under standard weather bureau conditions, at Fort Yukon in Alaska, just north of the Arctic circle. The Bureau occasionally reports 95° F., and has reported even 100° F. The Canadian Weather Bureau reports nothing above 88° F., but that is because its northern stations are strung out at intervals along the northward flowing Mackenzie River. On two journeys down this river (1906 and 1908), and from common report as well as from weather bureau observations, I know that there is on most occasions a wind blowing with almost the steadiness of a trade up the Mackenzie valley from the Polar Ocean. Explorers who have been in the Canadian Arctic, away from the Mackenzie wind-trough, have observed temperatures much higher than those recorded by the Weather Bureau.

We have, then, observational confirmation of the theory, according to which the polar regions receive about as much heat for five weeks in summer as does the equator.

Most observers reporting climate from the polar regions have done so from locations on shipboard or on a sea-coast, where the downpour of the summer sun's heat has been neutralised by the chill of the ocean stored up through a long and cold winter. It is true that the ground in the Arctic is frozen, and that the temperature of the earth 40 or 50 ft. down has been found to be about +10° F., whereas the ocean 50 ft. down would have a temperature about +29° F. Soil and even rock are, however, poor conductors of heat, and the ground chill is imprisoned, while the ocean chill is freely liberated. Furthermore, the great heat of summer produces on most land surfaces a mat of vegetation, which is an even poorer conductor of heat than the earth itself. This is why a thermometer 6 ft. above a damp meadow in the arctic regions of Alaska, protected from the sun's rays in the usual weather bureau way, is able to record temperatures ranging from 60° F. to 100° F. almost every day for a period of several weeks in midsummer.

Consider now what the weather conditions in the Arctic Regions would be if, instead of the present ocean ranging in depth from one to three miles, we had an extensive low land—say a continent as low and as flat as Australia, with the North Pole near the centre of it. Better still, assume that the low land of northern Siberia, with physical characteristics such as it now has, were to extend to and beyond the North Pole, including a large part of the Canadian Archipelago, or even joining up with North America itself. Remembering that the sun delivers about as much heat in the Polar Regions as in the Tropics in midsummer, and also the observation that frozen ground has little effect upon the temperature of the air above it, then according to recorded midsummer lowland temperatures at present in the Polar Regions, we should have at the North Pole July heat of so-called "tropical" intensity, and conditions all over the Arctic suitable for dense forests of black spruce and other trees and shrubs, without calling upon any further alteration in environment—such as different chemical composition of the atmosphere,

a shifting of the earth's axis, a change in the shape of the earth's orbit, or an increase of solar radiation.

It is well known that perpetual ground frost to within 10 or 15 inches from the surface does not interfere with the prosperity of a black-spruce forest. At Fort Macpherson, N.W.T., Canada, for example, we have trees a hundred feet high growing straight and close together, and yet I have observed in midsummer that the perpetual frost around their roots was less than a foot below the surface.

As stated above, I do not offer this explanation of certain of the coal measures in connexion with any allegation that the Arctic was once an extensive low land, but merely as an hypothesis which can be called upon in case other evidence shows that extensive low land may once have existed there.

Coal has been found in the Antarctic no less than in the Arctic. The Antarctic is at present in large part an extremely high continent, but it is at least worth considering whether it may not have been a low land at the time when the coal was formed there.

It has been abundantly shown that permanent snow on land in the polar regions depends on altitude and precipitation rather than latitude. Nansen has said that on the low land of northern Siberia no permanent snow has been found, and that he feels certain none can be found. Many travellers, including myself, have reported from northern Canada, northern Alaska, and from the islands to the north of Canada, the total absence of bodies of permanent snow large enough to be called glaciers, though there are small snow-drifts at the end of summer in the shadowed bottoms of deep ravines in some of the Canadian islands. Greenland is 90 per cent. covered with ice, but the largest ice-free area in Greenland is near its northern end, showing that altitude and precipitation rather than latitude are the controlling factors. The smaller glaciers of Franz Josef, Spitsbergen, Ellesmere, Heiberg, North Devon, and the one or two small glaciers of Baffin Island, depend similarly on altitude and precipitation. A mere change of altitude without change of area might therefore remove the whole ice-cap of Antarctica—or certainly it could be removed by a reduction to a general level below 2000 ft. and perhaps a slight increase in area. With the ice once gone, only the Antarctic shores would be kept cool in summer by the sea, the interior promptly adopting the extremely hot June and July weather now found in the Arctic lowlands, thus bringing conditions suitable for spruce forests and the development from them of beds of coal.

VILHJALMUR STEFANSSON.

The Trichromatic Theory of Colour Vision.

THE history of the spread of knowledge regarding the Young-Helmholtz theory of colour vision is a very curious one. As in the case of all other great theories, its range of possible application far exceeds the demands made upon it for the explanation of actual facts. Limitations have to be imposed upon it here and there in answer to inquiry as to which choice out of several has been the one adopted by Nature. This process is in accordance with the development of all great theories. In the earlier stages powerful restrictions are adopted in order that advancement may be made. When these are found to be too restrictive a wider postulate is made so as to include a wider group of facts within the scope of the theory; and, the whole development being simple and direct, the theory at last stands forth as no longer a theory but a fact greater and wider than any of the groups of facts which are contained within its bounds. Thus the electron theory is now, apart from certain tentative developments, a fact standing upon as wide a basis of experience as any so-called fact of which we are cognisant.

This statement also holds in the case of the kinetic theory in general. But, if the great developments by Clausius, Maxwell, and others more recently, were unknown; if nothing were known beyond the results of the early restrictive postulate of perfectly hard, spherical, smooth, and elastic atoms; commentators of to-day might readily be found condemning the theory, and asserting that it could not explain the facts which the recent workers have shown to be direct and simple consequences of its naturally developed postulates. This, or rather worse, is exactly the position with regard to many present-day criticisms of the trichromatic theory of colour vision. These are evidently made in entire obliviousness of developments actually made by Helmholtz himself.

A still more curious condition which subsists is that the commentators are not entirely worthy of blame. For the later developments have never become common scientific property in Britain, while the early developments became widely known.

As examples of the criticisms I give some statements taken from Dr. Edridge-Green's book on colour vision. In doing so I desire to make it clear that I am making no attack upon his valuable and interesting work; I am only replying to his strictures upon the Young-Helmholtz theory, in which he, in my view, inadvertently draws quite undeserved and wrong conclusions. In chap. xxx. he gives six arguments which he holds to be conclusive against the Young-Helmholtz theory of colour vision, and eight against the Young-Helmholtz theory of colour blindness. I assert, on the contrary, that the theory gives a simple and direct account of the phenomena in each case; and I give the mode of deduction in five cases.

"The theory does not explain why there should be a defect in hue perception in those who have lost one of their sensations." Now, actually, the theory explains it beautifully. Thus in any stretch of wavelengths in which two of the three sensation curves have opposite slopes, hue discrimination is correspondingly strong. Therefore annulment of one of these curves diminishes it.

"The theory does not explain why many dichromics have a luminosity curve similar to the normal." This is an example of overlooking the later developments of the theory. If the dichromasy arises from fusion of two of the sensation curves, the distribution of luminosity may be unaltered.

"There are not two or three definite varieties of colour blindness, as there should be according to the theory." Here again there is oversight. In the hard-smooth-elastic-spherical-atom stage of the theory this might have been asserted. Actually, according to the theory as left by Helmholtz, there may be a doubly infinite variety of cases of colour blindness.

"How could the loss of half of a hypothetical green sensation cause dichromatism?" The answer is simple. Given one sensation curve intersecting the other two, if lessening of its ordinates by one half makes it fall entirely within the others, dichromasy is present.

On p. 210, and also in the *Phil. Mag.*, Nov. 1922, Dr. Edridge-Green describes another case. "A man with shortening of the red end of the spectrum and normal colour discrimination will put together as exactly alike a pink and a blue or violet much darker. If, however, the pink and blue be viewed by a normal sighted person through a blue-green glass which cuts off the red end of the spectrum, both will appear identical in hue and colour. This

proves conclusively that the defect is not due to a diminution of a hypothetical red sensation, because all the rays coming through the blue-green glass are supposed to affect the red sensation, and yet we have been able to correct the erroneous match by the subtraction of red light."

Now the question of a longer or shorter spectrum with otherwise absolutely normal vision is one which can be dealt with equally easily by all theories. To show the power of the Young-Helmholtz theory, I shall take the most extreme case possible, that in which the peculiarity amounts to dichromasy. Let the pink and violet colours be represented by $x_1\mathrm{R}+y_1\mathrm{G}+z_1\mathrm{B}$ and $x_2\mathrm{R}+y_2\mathrm{G}+z_2\mathrm{B}$ respectively, in the usual trichromatic notation; and let the colour abstracted by the blue-green glass be $a_1\mathrm{R}+b_1\mathrm{G}+c_1\mathrm{B}$ in the case of the pink, and $a_2\mathrm{R}+b_2\mathrm{G}+c_2\mathrm{B}$ in the case of the violet. So the colours seen by the normal eye are $(x_1-a_1)\mathrm{R}+(y_1-b_1)\mathrm{G}+(z_1-c_1)\mathrm{B}$ and $(x_2-a_2)\mathrm{R}+(y_2-b_2)\mathrm{G}+(z_2-c_2)\mathrm{B}$ respectively. If these appear to be identical, we have $x_1-x_2=a_1-a_2$, $y_1-y_2=b_1-b_2$, $z_1-z_2=c_1-c_2$. These are the relations which must subsist amongst the unifiable colours and the colours absorbed by the unifying medium. Now let the dichromasy correspond to the condition $\xi\mathrm{R}+\eta\mathrm{G}+\zeta\mathrm{B}=\mathrm{O}$. The pink and violet are then expressible as $(x_1-z_1\,\xi/\zeta)\mathrm{R}+(y_1-z_1\,\eta/\zeta)\mathrm{G}$ and $(x_2-z_2\xi/\zeta)\mathrm{R}+(y_2-z_2\eta/\zeta)\mathrm{G}$ respectively. These being identical, we have $(x_1-x_2):(y_1-y_2):(z_1-z_2)=\xi:\eta:\zeta$, which are the conditions for Dr. Edrige-Green's case. The trichromatic theory, so far from being helpless, as he asserts, not merely accounts generally for the phenomenon, but tells quantitatively as well as qualitatively what is happening. W. Peddie.

Distribution of Megalithic Monuments.

Mr. O. G. S. Crawford, in Nature of May 5, p. 602, criticises what he terms my "speculations" concerning the distribution of megalithic monuments in England and Wales. I am sorry that apparently he did not trouble to read the paper, and to see exactly what I had to say on the matter. My aim was to urge that there is a connexion, in England and Wales, between the distribution of megaliths and certain geological formations, the Granite in Devon and Cornwall, the Chalk in Dorset and Wilts, the Lias in Gloucester and Oxford, and so forth. In this I found that I had been anticipated in part by Mr. Crawford himself. Where we differ, of course, is in the interpretation of the evidence.

An examination of the paper will show Mr. Crawford that I am well aware of the difficulties involved in the theory that the builders of megalithic monuments were attracted to this country by the stores of gold, copper, lead, and so forth, that it contained, and that I discussed the very points to which he directs attention. It must never be forgotten, however, that megaliths are found in all parts of the world, and that possibly the explanation of the presence of these monuments in one country may serve to explain their presence elsewhere. All I have done is to put forward the theory, based on evidence from all parts of the world, that the megalithic civilisation of western Europe was derived from a metal-using civilisation in the Ancient East.

The attention of all who are interested in the matter is being directed to the excellent work now being done by Mr. Crawford at Southampton, and we are all eagerly expecting the publication of the fresh distribution maps of megalithic monuments that Mr. Crawford promises us. But, admirable as such work is, the final solution of the problems presented by these monuments may, after all, come from a wide survey of facts derived from all parts of the world, and not necessarily from detailed work in a limited part of the field. W. J. Perry.

The University, Manchester.

The Concentration of Hæmoglobin in Blood Corpuscles.

I have very little doubt that Dr. Gorter is right in suspecting that the method which is commonly used for determining the volume of the red blood corpuscles by centrifugalisation is not trustworthy (Nature, June 23, p. 845). Whether the red corpuscles are biconcave discs or hollowed cones, or indeed, whatever their shape may be, they cannot be packed together without leaving spaces between them unless they are deformed: and if they are deformed there is every reason to be suspicious about their water content remaining unaltered.

The usual method is to centrifuge the blood until the volume of the cells ceases to become smaller, the apparatus generally making 3000 to 5000 revolutions a minute with a disc of something less than a foot. It is easy to convince oneself that the final result depends on just how the process is carried out, for it is different if the blood is first gently centrifuged, say at about 2000 revolutions, and then exposed to the full speed, from what it is if the high speed is used from the beginning. So dependent is the figure obtained on the precise details of the method that, if real comparisons between different bloods is required, it seems to be essential that they must be in the centrifuge simultaneously.

The method seems never to have been examined critically. What is wanted is a comparison between it and the results calculated from the concentrations in whole blood and in plasma of some substance present in plasma and not in red corpuscles, which can be estimated with a high degree of accuracy. Without some control of this kind the method must, for absolute values at any rate, remain under suspicion.

A. E. Boycott.

Medical School,
University College Hospital, W.C.

Effect of Plant Extracts on Blood Sugar.

Our studies in connexion with insulin led us to the conception that carbohydrate metabolism is performed by an oxidising ferment mechanism. This theoretical conception induced us to test vegetable material, known to contain oxidases and peroxidases, for oxidising substances having an insulin-like action. In December 1922 we injected 5 c.c. of juice from a new potato intravenously into a 1500 gm. rabbit and noted a fall of blood sugar in one hour from 0·17 to 0·13 per cent. Since then we have found that sterile pieces of raw potato, and juice expressed from these, introduced into a glucose solution, after incubation for twenty-four hours at 37° C., caused this to lose from 26 to 36 mg. of glucose per 100 c.c. These results were published in the *Jour. Amer. Med. Assoc.*, June 2, together with results indicating a diminished glycolytic power of blood from diabetics.

Winter and Smith published a note in the *Journ. Physiol.* 57, 40 (Nos. 3 and 4), 1922, which reached the United States in April last, and in Nature of March 10, p. 327, stating that they had obtained an insulin-like substance from yeast.

Collip, in Nature of April 28, p. 571, states that he, working independently, found an insulin-like substance in various vegetables, in yeast, and in clams. Collip's studies on insulin are of inestimable

value and made it possible to obtain insulin from animal pancreas in quantities for practical use. He expected to find an insulin-like substance wherever glycogen occurred in Nature, and for this reason looked for it in vegetable extracts. Our belief that oxidising ferments cause glucose metabolism led us to examine vegetables for these ferments and for substances with an insulin-like action. It seems that Collip's theory and ours dovetail. A storehouse of food (glycogen, starch, etc.) and a ferment for the metabolism of this food are necessary wherever growth occurs in vegetables.

Our studies have led us to the tentative suggestion that insulin, which is apparently not itself an oxidase or peroxidase, indirectly stimulates or activates oxidising ferments in the tissue cells to action upon glucose, whereas vegetable extracts contain active oxidising ferments and act directly when injected into animals.

It would seem that the work of Winter and Smith, of Collip, and of ourselves was being carried on simultaneously and independently. Collip, very properly, suggests that "These authors [Winter and Smith] would, therefore, share coincident priority with me in this particular." We think that we should be included in this share of priority.

William Thallinner.
Margaret C. Perry.

Laboratories of Columbia Hospital,
Milwaukee, Wis., June 20.

Scientific Names of Greek Derivation.

Dr. J. W. Evans's letter in Nature (July 7, p. 9) may serve as an excuse for commenting on certain names which have recently been introduced into zoological literature without sufficient regard for etymological principles. Bathosella and Leiosella (Polyzoa) may be given as examples of a series of new genera, proposed in 1917 and later years, with the derivations, as stated, *bathos*, depth, and *leios*, smooth, respectively. In these genera the entire Greek word is used, instead of its root, and the generic name is completed by the addition of a Latin diminutive termination. The suffix *-sella* is in any case likely to cause confusion in Polyzoa, among which *-cella* is the termination of many familiar generic names.

A second series of new genera ending in *-nea* is also of recent introduction, to express an affinity to Idmonea, which was presumably based on ἴδμων. Mesonea and Pleuronea may be mentioned as examples of this misused employment of *-nea*. A third unfortunate suggestion has just been made, to the effect that the Latinised form of ξένος or ξένη (a guest) should be added to the generic name of a host, in forming the trivial name of its parasite. Among the illustrations of this supposed emendation in nomenclature are *ranaxena* and *bufoxena*, both based on Latin words.

According to the Rules of Nomenclature, generic and trivial names cannot be rejected on purely etymological grounds. The same rules do not apply to group-names, and it is accordingly justifiable to suggest that some of them may be amended; for example, that Aplousobranchiata, which has been proposed in Tunicata, should be replaced by the more euphonious name Haplobranchiata.

Dr. W. D. Lang (*Geol. Mag.*, N.S., December, vol. iv., 1917, p. 282) has previously discussed some of the points I have indicated. It may be useful, however, to raise a protest against the continued introduction of names formed in defiance of accepted principles, and I venture to think that this practice will not tend to raise scientific nomenclature in the estimation of scholars.

Sidney F. Harmer.

British Museum (Natural History),
July 7.

In 1844 Sir John Herschel wrote to Owen regretting his spelling of the name of the fossil bird Dinornis, and urged that a Frenchman would pronounce the word Denornis, which he would not do had it been spelt Deinornis. To this Owen answered by directing attention to our pronunciation of the word receive.

Herschel does not seem to have retorted, but he might have done so by quoting—

"segnius irritant animos demissa per aurem
quam quae sunt oculis subiecta fidelibus et quae
ipse sibi tradit spectator."

And the retort would have been final.

F. Jeffrey Bell.

The Athenæum, Pall Mall, S.W.1,
July 8.

The Scattering of Light by Anisotropic Molecules.

Prof. L. V. King's interesting letter on this subject in Nature of May 19, p. 667, calls for comment, as his results do not seem to be acceptable in the light of the work carried out at Calcutta in this field during the past two years.

Any proposed scattering formula should satisfy two simple tests, namely, that for a fluid consisting of isotropic molecules it should reduce to the Einstein formula, and that for a sufficiently rarefied fluid it should become the Rayleigh law of scattering. Prof. King's formula (3) satisfies neither of these tests, as can easily be seen on putting $\rho=0$ in it. The appearance of the adiabatic compressibility in the formula is inconsistent with thermodynamic principles. Einstein has very clearly pointed out that the expression for scattering must involve the isothermal and not the adiabatic compressibility. Further, the omission by Prof. King of the factor $(\mu^2+2)^2/9$ which appears in Einstein's formula, cannot be reconciled with the acceptance of the Lorentz refraction formula for a fluid consisting of isotropic molecules.

Prof. King's explanation of the diminution in the depolarisation in the case of liquids, which occurs as the critical temperature is approached, as due to the breaking up of crystalline aggregates, seems inappropriate in view of the fact that a precisely similar effect is shown by vapours, where obviously the conception of crystalline aggregates is entirely out of place. Mr. Ramanathan's paper on the scattering of light in benzene vapour at high temperatures, which is appearing in the *Physical Review*, clearly illustrates this. The effects observed both in liquids and vapours have been very simply explained without recourse to artificial hypotheses in my papers in the *Phil. Mag.* for January and March, where quantitative data strongly supporting Einstein's formulæ are set out.

The fundamental error in Prof. King's reasoning seems to arise at the point where he suggests that a fluid consisting of comparatively stationary anisotropic molecules, with equally probable orientations in all directions, would scatter only polarised light. This is certainly not the case. It can easily be seen on resolving the effect due to an ælotropic molecule oriented arbitrarily that the components perpendicular to the light vector in the incident wave are affected with a sign which may be either positive or negative at random, *i.e.* irrespective of the position of the

molecule in space, and hence, in finding the total components in these directions, we have to add the intensities, not the amplitudes. A fluid consisting of anisotropic molecules oriented at random must therefore necessarily scatter unpolarised light in proportion to its density, and as remarked in my letter in NATURE of March 31, p. 428, considerations similar to those which enter into the Lorentz refraction formula introduce a further factor $(\mu^2+2)^2/9$, which increases the unpolarised scattering to be expected. The whole question will be found elaborately discussed in a paper by Mr. Ramanathan in the Proc. Indian Association for the Cultivation of Science, vol. viii., Part I., just published.

I think I should make it clear that the suggestion made in my letter in NATURE, March 31, and endorsed with some modifications by Sir William Bragg, regarding the relations between the liquid and the crystalline states, is very different from that put forward by Prof. King. In my opinion, neither the facts regarding the scattering of light nor the X-ray data require the assumption of the existence of crystalline aggregates in liquids. All that the experimental facts suggest is that the molecules in a liquid influence the orientations of their nearest neighbours to a sensible extent, and that this results in the amount of unpolarised light scattered being somewhat smaller than on the hypothesis of random orientations of the molecules.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta,
June 15.

The Doublet Separations of Balmer Lines.

IN his theory of the structure of the lines of the Balmer Series based on the principle of relativity, Sommerfeld shows that each of the members of the series should consist of a doublet and that each of the components of these doublets should possess a fine structure. The calculations show besides that the frequency difference for these doublets should be constant over the whole of the Balmer Series and should be equal to 0·36 cm⁻¹. For H_α the separation should perhaps be slightly less. As the theory applies equally well to the doublets of the corresponding series in the spectrum of positively charged helium, these were investigated by Paschen and were found to have separations that lead to a value of $0{\cdot}3645 \pm 0{\cdot}0045$ for the frequency difference of the doublets of the Balmer Series.

Since the publication of Paschen's work on helium a number of investigators, including the writer, have attempted from the measurements on the separations of H_α and H_β and in some cases of H_γ and H_δ to look for evidence that would lead to a confirmation or rejection of Sommerfeld's theory. Up to the present the results obtained could not be considered as satisfactory. There was a lack of agreement in the values obtained for the separations by different investigators, and on the whole the values obtained were less than that demanded by the theory. In the case of the observations made by myself and Mr. Lowe on the separations of H_γ and H_δ, values were obtained that seemed to point in the direction of a steady decrease in the frequency differences as one passed to the higher members of the series.

At my suggestion the matter was re-investigated recently by one of the research workers in the Physical Laboratory of the University of Toronto, Mr. G. M. Shrum. In his experiments the tubes were of a special design and were cooled with liquid air.

His method of operating these tubes, which will be described later in his own paper, enabled him to eliminate practically the whole of the secondary spectrum and thus permitted him to include in the measurements of the doublet separations that of H_ϵ as well as those of H_α H_β H_γ and H_δ.

The results are the following:

Line.	Wave-length.	Separation of the Components.		Probable Error.
		$\delta\lambda$.	$\delta\nu$.	
H_α	6562·79 Å	0·143 Å	0·33 cm⁻¹	0·02 cm⁻¹
H_β	4861·33 ,,	0·085 ,,	0·36 ,,	0·01 ,,
H_γ	4340·46 ,,	0·070 ,,	0·37 ,,	0·02 ,,
H_δ	4101·73 ,,	0·061 ,,	0·36 ,,	0·02 ,,
H_ϵ	3970·07 ,,	0·055 ,,	0·35 ,,	0·02 ,,

It will be seen that as far as the doublet separations are concerned, they afford a striking confirmation of Sommerfeld's theory.

J. C. McLENNAN.

The Athenæum,
July 2.

"Guide to the Mollusca."

WITH reference to the review of the "Guide to the Mollusca" in NATURE of July 21, p. 93, may I be allowed to point out that our rather cautious statement, "A species of *Helix* has been said to tolerate a temperature of −120° C.," was based on Pictet's paper "De l'emploi méthodique des basses températures en biologie" (Arch. Sci. Phys. et Nat. Genève (3) xxx., 1893, pp. 293-314). The reviewer's remark about the scientific names of the pearl mussel and the pearl oyster scarcely makes it clear that we are simply keeping to the names used by the late Mr. E. A. Smith in 1908, *Margaritana margaritifera* for the mussel and *Margaritifera margaritifera* for the oyster. I hope that the other errors he has discovered are not more serious than these.

C. TATE REGAN
(Keeper of Zoology).

British Museum (Natural History),
Cromwell Road, S.W.,
July 23.

MR. REGAN is quite right to direct attention to the fact, which I should have noted, that the confident statement in the text-book concerning the survival of a species of Helix submitted to a temperature of −120° C. had been altered from "has been known" to "has been said," but I still think it would have been better to have omitted it altogether. Pictet in his paper does not say whether the degrees he cites were registered by any one of the more usual thermometers or by a scale of his own (the "C" is an addition in the text-book), and his paper altogether does not suggest that amount of accuracy which the subject demanded. The admission that a system of nomenclature nearly a quarter of a century old has been deliberately adhered to in a work supposedly brought up-to-date, speaks for itself. Much progress has been made in this section of systematic zoology since 1908, and according to all the Rules the pearl oyster (Pinctada) has no right to the name Margaritifera, which belongs to the pearl mussel. There are other examples in the "Guide" of what a malacologist of to-day would call misnaming.

THE REVIEWER.

The Temperatures of the Stars.

By Herbert Dingle.

THE measurement of the temperature of a star is one of the most difficult problems of physical astronomy. The difficulties are of two general kinds. In the first place, the very phrase, "the temperature of a star," has no meaning: we may as well speak of the latitude of the land surface of the earth. There can be no doubt whatever that the temperature varies from one part of a star to another over an enormous range—probably thousands of times greater than the interval between the temperatures of liquid hydrogen and the electric furnace. Secondly, for experimental methods of measurement the only available data are wrapped up in an inconceivably small fraction of the total radiation of the star which reaches the earth after the possible wear and tear of many years' journey through interstellar space and our own atmosphere. From the character of that radiation we have to deduce the temperature of the star. From these two general sources difficulties of many kinds issue forth.

Happily, the resources of modern physics make the problem anything but hopeless. The "temperatures" of a number of stars have been determined by different methods, though exactly what the figures mean, and how much reliance can be placed on them, are perhaps still matters of doubt. With regard to the first source of difficulty, considerable help is received from the spectroscope. More than ninety-nine per cent. of recorded stellar spectra consist of absorption lines on a continuous background—conclusive evidence that a star consists of at least two distinct parts. In the light of Kirchhoff's principle, the continuous spectrum is attributed to the hotter, deeper-lying part, and the absorption lines to a surrounding cooler, but still luminous, atmosphere. Accordingly, temperatures measured from the characteristics of the absorption lines must apply to the atmosphere, and temperatures measured from the continuous spectrum must apply to the interior.

The next questions are evidently: Do the atmosphere and the interior, as thus defined, comprise the whole star, or are there regions outside the one and beneath the other? In the former event, what parts of the atmosphere and the interior have the respective measured temperatures, and, in the latter event, what are the temperatures of the unconsidered regions? For the answers to these questions we are indebted mainly to the nearest star—our sun. We know, from observations made possible by a total solar eclipse, that outside the sun's atmosphere (*i.e.* the source of the absorption spectrum lines) there is the corona—evidently a permanent though ever-changing part of the solar structure. We know also that the source of the sun's continuous spectrum is effectively a layer of limited thickness near the surface, because the luminosity of the sun's disc does not fall off appreciably outwards from the centre until the limb is nearly reached. There must, therefore, be a core inside what we have called the "interior," about which, from direct observation, we know nothing. We may assume, then, that in addition to the regions the temperatures of which we measure from the spectrum of a star, there are other very extensive regions, the temperatures of which it is at present quite impossible to determine by any experimental means.

The temperature throughout the atmosphere of a star may be regarded as a constant quantity. To solar eclipses, again, we owe the knowledge that the sun's atmosphere is very thin compared with the depth of the whole globe. It is true that there are indications that its physical condition varies at different levels, but these variations are refinements of analysis which we cannot hope to apply to the stars for a long time to come. If we can determine a temperature from the absorption lines in the spectrum of a star, we are justified in supposing that we can state definitely the temperature at a particular part of the star. The case is not so clear when we come to the continuous spectrum. We do not know at all definitely from what part of the star the continuous spectrum comes. We know that it must come from beneath the atmosphere, and it has just been pointed out that it represents the radiation of a surface layer, which we may call the "photosphere," but how thick that layer is, and what part of it has the temperature deduced from its spectrum, are questions that are still unanswered.

The first set of difficulties, then, can be partly overcome. Assuming that the sun is a type of its kind, we can divide a star into four distinct parts—a corona, an atmosphere, a photosphere, and a core. Of the temperatures of the first and last, we know, by direct experiment, nothing. The temperature of the second can possibly be measured definitely, and that of the third, vaguely. Supposing these measurements to be made, theory indicates, for certain stars, what must be the temperatures at different parts of the core.

Turning now to the second set of difficulties—those connected with the actual measurement of the temperatures—we note that these may be subdivided into the difficulties of obtaining the requisite data, and those of interpreting the data when they are obtained. It is probably fair to say that, in measuring atmospheric temperatures, the former preponderate, while the latter are most in evidence in the measurement of photospheric temperatures. It was Lockyer who first showed the influence of temperature on the line spectrum of a substance, and urged that the relative temperatures of stellar atmospheres could be determined from a study of the lines by which particular substances were represented. More recent investigations, originated by Saha, have confirmed Lockyer's views, and have shown how the actual temperatures can be calculated. But it appears that, while temperature is probably the chief factor in determining the line spectrum, it is by no means the only one. Pressure, the absorption of photospheric radiation, the relative amounts of different substances in the atmosphere, the ionisation potentials of the elements—these at least play a part, and must be determined before the temperatures can be found. Unfortunately, they are, in most instances, unknown, and their values have to be assumed, on more or less plausible grounds. There is, therefore, a considerable element of uncertainty in existing estimates of the temperatures of stellar atmospheres.

The temperatures of the photospheres are deduced from the distribution of energy in the continuous spectra. Laboratory experiments on black-body radiation show that the spectrum of a perfect radiator at uniform temperature is characteristic of the temperature. Wien's displacement law states that the wave-length of the radiation carrying the maximum amount of energy is inversely proportional to the absolute temperature of the source of radiation, and Planck's radiation formula expresses, with great accuracy, the distribution of energy throughout the spectrum. Assuming that the photosphere of a star bears the same relation to its continuous spectrum as does the equivalent of a black body in the laboratory, the photospheric temperatures are found. Wilsing and Scheiner, of Potsdam, and Nordmann, of Paris, have used the method, and Sampson has recently shown that, by employing a photo-electric cell as an energy detector, the accuracy of the measurements may be greatly increased.

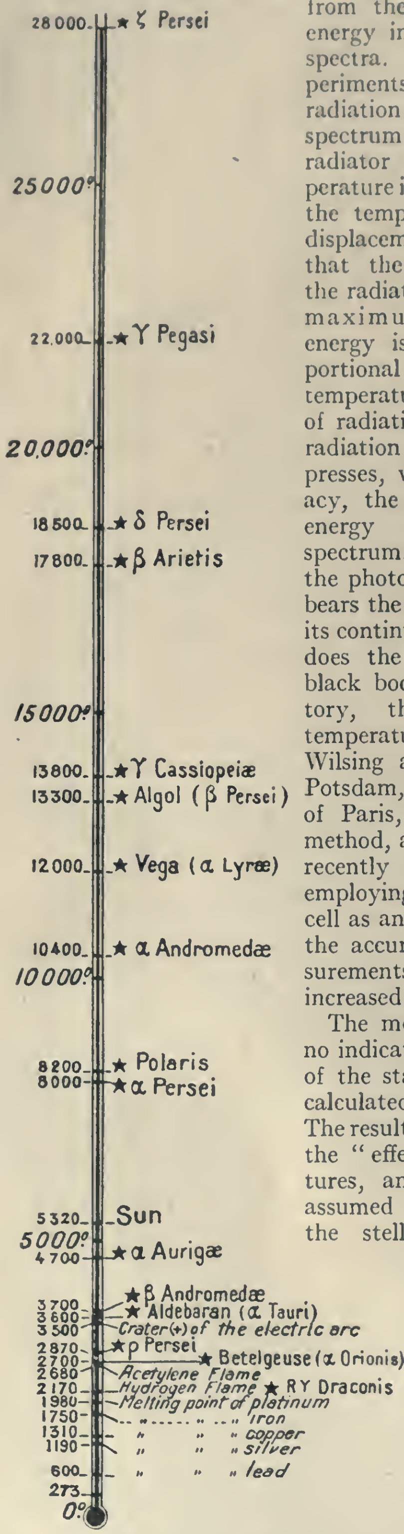

Fig. 1.—Scale showing, in absolute centigrade degrees, the temperatures attained in certain terrestrial processes compared with the effective temperatures of representative stars.

The measurements give no indication of the region of the star which has the calculated temperature. The results are spoken of as the "effective" temperatures, and are generally assumed to characterise the stellar surfaces, immediately beneath the atmospheres. Two remarks might be made concerning them. First,—granting for a moment the validity of the method of measurement, they represent minimum temperatures only, for if the stars are not perfect radiators, their temperatures must be higher than the calculated ones. Second,—it is a somewhat dangerous assumption that the resultant radiation from a globe of gas, perhaps millions of miles in depth and varying in almost every physical quality from point to point, will give a spectrum comparable with that of a thin solid surface at a uniform and probably very much lower temperature. We know practically nothing as yet of the processes of production of continuous spectra. We have no means of distinguishing one such spectrum from another except by measuring the distribution of energy in it; yet it is certain that there may be profound differences in the modes of origin. The continuous spectra of a cold fluorescent body, of an electric glow-lamp, of hydrogen radiating also the Balmer series—here at least are three spectra which probably have nothing in common except their appearance. The stellar nuclei of planetary nebulae, again, give spectra which suggest the operation of the classical laws of radiation rather than those of the quantum theory, unless the stars have temperatures so high that no one is prepared to accept them.

It is noteworthy, however, that the atmospheric and photospheric temperatures, estimated by totally different, and at best approximate, methods, are of the same order of magnitude. Fig. 1 [1] shows, on a thermometric scale, the range of temperatures covered by present measurements. Temperatures have been measured at almost all points intermediate between the absolute zero and the temperature of ζ Persei. The cores of the stars, according to Eddington's theoretical researches, reach temperatures far too high to appear on the scale. It is probable that there are bodies in the universe at all temperatures between absolute zero and 20 million degrees centigrade or higher.

Whatever may be said of the absolute accuracy of stellar temperature measurements, it is scarcely questionable that they show the true order in which the temperatures are arranged. There is no doubt whatever that Vega is hotter than Aldebaran in corresponding regions. Consequently, if the order of stellar evolution can be established from other data, it becomes possible to determine the changes of temperature of a star throughout its life. Russell's well-known theory of evolution takes the order of increasing density of a star to be its order of development: contraction is a continuous process from childhood to old age. This implies that a star passes twice through the same series of spectral types, and therefore through the same series of temperatures. Beginning as a huge, rarefied, cool mass of gas, it contracts and becomes hotter until a stage is reached when it is too dense to obey the laws of a perfect gas. The temperature then soon reaches a maximum and begins to fall—contraction, however, continuing, though at a slower pace—and the star retraces its path through the sequence of spectral types which it traversed on its upward journey. While the temperature is rising, the star is a "giant," and after it begins to fall the star becomes a "dwarf." The career of a typical star, with time as abscissa and temperature as ordinate, is pictured in Fig. 2: continuous contraction is indicated by the decreasing diameter of the circles representing the star.

[1] The diagrams illustrating this article are adapted, by kind permission of Dr. Charles Nordmann, from an article by him on "La vie et la mort des étoiles," which appeared in *L'Illustration* of April 7, 1923.

The temperature reached at the maximum point depends on the mass of the star: the greater the mass, the higher the temperature and the longer the stellar life. Fig. 3 illustrates the careers of the sun and of stars the masses of which have nearly the extreme values found in Nature. Probably a star having a mass less than one-tenth of that of the sun would not become hot enough to be seen, while Eddington has shown that stars much more than ten times as massive as the sun would be unstable. Only the most massive stars can reach the B and Oe 5 stages of the Harvard spectral sequence. The lighter stars, like the sun, turn back at the A condition, or even at a still lower stage.

Temperature appeared at first, in this great stellar drama, to play a dependent rôle. The star developed heat by contraction, and radiated heat into space. So long as the amount of heat developed exceeded the amount radiated, the temperature would rise, and when, through retardation of contraction and increase of radiation, the conditions were reversed, the temperature would fall. This view is satisfactory in every respect but one—it indicates a length of stellar life far shorter than geological and other evidence makes it possible to admit. In order to account for the amount of heat which a star radiates during its immeasurably long life, it is necessary to suppose that the heat generated by contraction is supplemented by an enormous supply of energy from some other source. Nothing is certainly known of the nature of this supply. Possibly, as Eddington proposes, it is to be found in the formation of heavier elements from hydrogen. But, wherever the energy comes from, it is difficult to avoid the hypothesis that it can be released only at the extremely high temperatures attained near the centres of stars. Contraction raises the temperature of a star up to a certain point, and then temperature takes charge and sets free energy from the unknown source at a rate almost equal to the rate of radiation, so that the star is in a condition of approximate equilibrium. It is a problem for the future to determine the origin of the almost inexhaustible supply.

FIG. 2.—Diagrammatic representation of the theoretical development of a massive star from an original nebula to a final cold, dense body. The dotted curve is to be regarded as identical with the highest curve in Fig. 3.

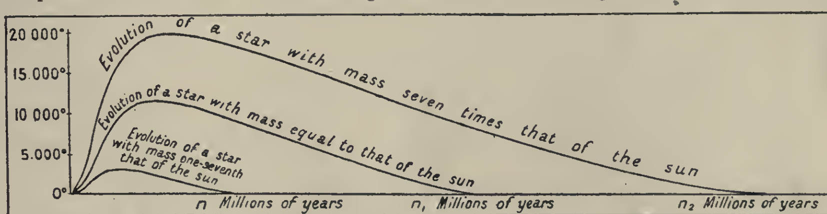

FIG. 3.—Curves illustrating the course of evolution of stars of differing mass, showing that, the more massive the star, the longer is its life and the greater is the range of temperature through which it passes.

Man and Scottish Animal Life.[1]

By Dr. JAMES RITCHIE.

IN the opportunity it affords for the study of the part man plays in the evolution of a fauna, the animal life of Scotland stands alone. This is largely due to a series of geological accidents: the Glacial Period, which made a clean sweep of former faunas; the post-glacial continental land bridge, which allowed immigration from the mainland of Europe, and the subsequent breaking of the continental connexion. Thus there was isolated on the *tabula rasa* of Scotland a fair sample of the post-glacial European fauna, which henceforth was removed from the possibility of subsequent migrations such as complicate the history of continental faunas, and the later evolution of which must in general be due either to the influence of physical and organic changes limited in time and space, or to the interference of man.

The influence of man was itself strictly limited in time, for the earliest human settlements so far recognised in Scotland date back only to Azilian times. It was also unequal in its incidence, gaining in intensity with the passing of time. Thus during the Neolithic, Bronze, and early Iron Ages only some four of the larger members of the original fauna disappeared—the giant fallow deer, the lynx, the lemming, and the rat vole—and it is doubtful whether the disappearance of any of these was due to man's presence. We may say, therefore, that when the Roman legions followed Agricola northwards through the marshes of Scotland in the early years of our era, they found a fauna which, except for the presence of primitive domesticated animals, differed little in kind from that which greeted man on his first arrival in Scotland some 8000 years before. But the following centuries saw more rapid changes, which so increased that by the sixteenth century many new and important elements had been added, while most of the larger members of the old fauna had been swept away, with the extermination of such as the reindeer, the elk and the wild boar, the brown bear and the beaver, the great bustard, the crane and the bittern. Nowadays the content and assortment of the fauna, the relative numbers of its members and their distribution, show little resemblance to the conditions of the original post-glacial immigrants.

The degree of man's interference may be compared

[1] Summary of an address delivered at the request of the Council to the Royal Society of Edinburgh on July 2.

with the influence of the ordinary forces of Nature which are constantly modifying the animal life of a country. There is a constant ebb and flow within a fauna, a swing of numbers due largely to seasonal changes and fluctuating about a mean—the "balance of life"; and where man's interference is temporary in its incidence it falls into this category. But there is, besides, a definite faunal evolution, a faunal drift; and where man's influence is persistent in one direction it must be reckoned as sharing with the great secular forces of Nature in propelling a fauna upon a path along which there is no return.

The nature of man's interference, directly or indirectly exercised upon the animal life of Scotland, is of great complexity, but it may be conveniently grouped according to results. In some ways man has reduced the numbers of animals, in some ways he has increased their numbers, and in some ways he has modified their habits and even their structures. Reduction of the fauna, which, commencing with a mere cutting off of the numbers of a species, may proceed to a marked limitation in the range of distribution and finally to extinction, has been brought about directly by deliberate destruction, as in the cases of the polecat and the urus, and indirectly by cultivation, which has destroyed feeding grounds and breeding haunts, driving away such as the great bustard and the bittern, as well as by destruction of the forest. with which disappeared the capercaillie and the red squirrel, both since reintroduced. Increase in the quantity of the fauna is largely due to an intensive cultivation which has provided bounteous food-supplies for such as rabbits and sparrows, and to deliberate protection of other creatures for food, sport, or amenity. The quality of the fauna has been increased by the addition of new elements from other lands, either introduced deliberately, like pheasants and the common rabbit, or carried hither by mischance of international commerce, like the black and brown rats and many an insect pest. Habits have been changed: the one-time cliff-dwelling swallow has been converted into an inhabitant of houses; and structures have been changed in converting wild into domesticated animals, and by the alteration of habitats, whereby the red deer has lost many points from its antlers and several cubits from its stature.

It must not be imagined, however, that a simple enumeration of first effects exhausts the tale of man's interference. The story of the effect produced, by protecting a few black-headed gulls, upon the vegetation of a heather moor and its fauna (which I have described elsewhere) illustrates how the slightest interference with wild life may produce complicated and far-reaching results, and that in a remarkably short space of time.

A final comparison of the modern fauna of Scotland with that found by Azilian man on his arrival on these shores, shows that the modern fauna is much more rich in numbers than the old fauna, and that in addition, in spite of the extermination of many forms, it is also more varied in species. The consistent tendency throughout the period of man's presence has been for the larger animals, which formed the most impressive contingent of the wild life, gradually to be rooted out; while the additions consist largely of lesser creatures, many of which have gained entry only because their minuteness has enabled them to escape detection. The great change therefore has been a notable diminution in the standard of size of the wild fauna, and this tendency is still strongly marked in the evolution of the Scottish fauna at the present day.

Obituary.

Mr. S. S. Hough, F.R.S.

Mr. Sydney Samuel Hough, H.M. Astronomer at the Royal Observatory, Cape of Good Hope, died on Sunday, July 8, at Gerrard's Cross. He had visited Europe last summer and had attended the meeting of the International Astronomical Union at Rome, but after his return to South Africa he was in poor health and ultimately cancer was diagnosed. He came back to England under the care of a nurse in the spring of this year and succumbed to the disease after a painful illness.

Mr. Hough was born at Stoke Newington on June 11, 1870. After distinguishing himself at Christ's Hospital School, he proceeded to St. John's College, Cambridge, as a foundation scholar. At Cambridge he had a brilliant career and graduated as third wrangler in 1892. He was awarded the first Smith's prize in 1894, and soon after was elected to an Isaac Newton studentship and to a fellowship at his college.

After taking his degree, Mr. Hough devoted himself to research work in astronomy and geophysics. It had recently been found by Küstner and Chandler that the free period of the variation of latitude differed from that predicted by Euler, and the investigation of this subject was undertaken by Mr. Hough. He passed on under the guidance of Sir George Darwin to an investigation of the tides on dynamical principles, and succeeded in deriving a more complete solution of the tidal problem than had been previously obtained, and indeed in making the most important contribution to this theory since Laplace. In his work he introduced the mutual gravitation of the water, and he determined the periods of free oscillation of the ocean. At this time he also did some work on periodic orbits.

When Mr. Finlay, chief assistant at the Cape Observatory, retired in 1898, Sir David Gill, who was then H.M. Astronomer, pointed out to the Admiralty the importance of selecting as his successor a man with the highest scientific qualifications who might be expected ultimately to become director of the observatory. In accordance with this plan Mr. Hough was selected for the post and he proceeded at once to take up his duties. He became H.M. Astronomer in 1907.

Mr. Hough threw himself into the work of the observatory and made valuable contributions to astronomy in organising and discussing observations, particularly those relating to the exact positions of the stars. This work is of a kind which does not attract much public notice, but it is absolutely fundamental to astronomy. Soon after his arrival at the Cape he was entrusted with the reduction of a triangulation of close circumpolar stars made with the

heliometer. These observations were carefully discussed for systematic errors and combined with meridian and photographic observations so as to give accurate positions of all the brighter stars in this region. The subject of the accurate positions of southern circumpolar stars engaged Mr. Hough's attention to the end, and four parts of Vol. XI. of the Cape Annals deal with these stars.

Mr. Hough's chief work was done with the new Cape Reversible Transit-Circle. This instrument is probably the best of its kind in existence and was designed by Gill with a view of the elimination of all conceivable sources of error. The principal parts of the instrument arrived at the Cape in 1901, but a considerable time naturally elapsed before it was ready for use with its collimators and underground azimuth marks in position. In 1903 and 1904 Mr. Hough spent a large part of his time in the determination of the constants of the instrument, in particular the error of every one of the 5′ divisions of the fixed circle was determined. The new transit circle was brought into regular use in 1905. Under Mr. Hough's direction two catalogues of fundamental stars based on observations for the years 1905–11 and 1912–16, containing respectively 1293 and 1846 stars, have been published. Each star has been observed at least sixteen times, four times in each of the four positions of the instrument, and the resulting star places must be among the most accurate we have.

Under Mr. Hough's direction, rapid progress has been made in the completion of the Cape Astrographic Catalogue, Declination 40° to 52° South. Five volumes of measures have now been issued, and this year a magnificent volume giving the spherical co-ordinates of all stars down to and including the 9th magnitude of the C.P.D. scale. There are in all 20,843 stars in this catalogue, and the places have been deduced from all the material available both from the meridian observations and the photographic plates. The overlapping parts of the plates have been carefully compared and the plate constants adjusted so as to give the best agreement possible. This volume has entailed a large amount of work and must prove of the greatest value in the future.

It is impossible to enter here at length into the different phases of Mr. Hough's work. The meridian observations of the inner planets and the heliometer observations of the outer planets have been carefully collected and discussed. In conjunction with Mr. Halm he discussed the motions of the Bradley stars, and he has derived an accurate value of the solar parallax from the radial velocities of stars as observed at different seasons of the year. Besides giving observations of the greatest accuracy the Cape Publications contain valuable discussions for the derivation of the fundamental constants of astronomy.

Mr. Hough's contributions to astronomy were recognised in various ways. In 1902 he was elected F.R.S. He was president of the South African Philosophical Society in 1907, and on the reconstruction of that society as the Royal Society of South Africa he was elected its first president. Last year he was elected British vice-president of the International Astronomical Union. His death at the age of fifty-three is deeply felt by astronomers throughout the world.

J. J.

SIR HENRY H. HOWORTH, K.C.I.E., F.R.S.

BY the death of Sir Henry Hoyle Howorth on July 15, at the age of eighty-one, scientific circles lose a characteristic figure belonging to a generation which has almost passed away, while his many friends mourn the loss of one for whose qualities all had an intense respect and admiration. A man of strong individual character, he had foibles which he himself was not the last to regard with some humour. His most remarkable characteristic, however, was his wide intellectual range and the vast, and sometimes surprising, extent of his knowledge. A constant attendant at the meetings of many scientific societies, there were few subjects on which he was not prepared at a moment's notice to make a real contribution to discussion.

Born in Lisbon on July 1, 1842, Howorth was educated at Rossall School and called to the Bar by the Inner Temple in 1867. He soon, however, turned his attention to politics and historical and archæological studies, which became his main interests in life. Of the large number of scientific and historical works on a variety of topics which he published, the first were two papers dealing with the races of Northern Russia and the extinction of the mammoth respectively, which were presented to the British Association in 1868 and 1869. They were followed by a number of papers published in rapid succession in the journals of scientific societies such as the Royal Anthropological Institute, the Royal Historical Society, the Royal Asiatic Society, and the like. They dealt, among other subjects, with the ethnology and history of the peoples of Central Asia and Eastern and Central Europe and with geological topics connected with the polar areas, and may be regarded as preliminary studies for the works with which his name will mainly be associated in the future. Of these, one, his "History of the Mongols," of which the first volume, dealing with the Kalmucks and Eastern Mongols, was published in 1876, the second, dealing with the Tartars, in 1880, and the third, on the Mongols of Persia, in 1888, brought him recognition in the form of the K.C.I.E. in 1892 and election to the fellowship of the Royal Society in the following year. He also published a "History of Chengis Khan and his Ancestors" in the *Indian Antiquary*. He had begun to rewrite his "History of the Mongols"; but the revision was incomplete when he died.

For the ordinary individual these detailed studies of Asiatic history and ethnology might well have sufficed; but they were not adequate to satisfy the needs of an intellectual energy so indefatigable as that of Howorth. He took up the study of glacial problems with equal zeal, and, be it said, with his usual love of controversy. "The Mammoth and the Flood" appeared in 1887, and "The Glacial Nightmare" in 1893, both being parts of a vigorous attack on Lyell's glacial theory, based upon palæontological, geological, and archæological evidence and suggesting that the deposition of drift and boulders was due to wave, rather than glacial, action. He followed this up with "Ice or Water?" which appeared in 1905. At the time of his death he was engaged on the revision of "The Mammoth and the Flood."

Sir Henry was also keenly interested in the history of the Church, and was the author of a valuable and

authoritative study of St. Gregory the Great, which was followed by "Augustine the Missionary." He also wrote "The Golden Days of the Early English Church," published in 1916, and edited a "History of the Vicars of Rochdale" for the Chetham Society.

It is surprising that, amid all this literary and scientific activity, Sir Henry should have been able to devote so much time to politics and public affairs, on which he was a frequent and voluminous writer in the correspondence columns of the Press. He was elected member of Parliament for South Salford in 1886, 1892, and 1895. In 1902 he did not seek re-election. Although he sat as a Unionist, he adopted an independent attitude, giving a free rein to powers of criticism and controversy which lost nothing by his command of language.

In addition to the honours already mentioned, Sir Henry Howorth was an honorary D.C.L. of Durham University, a trustee and honorary librarian of Chetham College, and, from 1899, a trustee of the British Museum. He had been president of the Royal Archæological Institute and the Viking Society, and was a vice-president of the Royal Asiatic and of the Royal Numismatic Societies.

Dr. Louis Bell.

Dr. Louis Bell died at his home at West Newton, Mass., on June 14. He was born in Chester, New Hampshire, in 1864, and twenty years afterwards graduated at Dartmouth College. He then specialised in physics and applied engineering, receiving the Ph.D. degree from Johns Hopkins University in 1888. In the same year he was elected professor of physics at Purdue University, Lafayette, Ind. He edited the *Electrical World* from 1890 to 1892, and was then appointed Chief Engineer of the power transmission department of the General Electric Company. In this capacity he installed at Redlands, California, the first three phase transmission plant which was used for general service. From 1895 to 1905 he lectured on power transmission to the Massachusetts Institute of Technology, while for twenty-seven years he was a consulting engineer in Boston.

Dr. Bell did excellent pioneering work on illuminating engineering and on power transmission. His "Electric Power Transmission," published in 1897, was for several years the standard textbook on the subject. For many years also his "Art of Illumination," published in 1902, was the standard work on illuminating engineering. He contributed articles on "Electrical Power Transmission" and on "Electric Motors" to the 10th and 11th editions of the "Encyclopædia Britannica," and published many technical articles chiefly on alternating currents, electric traction, illumination, physiological optics and radio-telephony. He was a manager of the American Institute of Electrical Engineers from 1891 to 1894 and was a past president of the American Illuminating Engineering Society. His work on photometry for the International Electrical Commission was much appreciated by engineers all over the world.

The former Director-General of the German Continental Gas Co., Dr. W. v. Oechelhaeuser, died on May 31, at Dessau (Anhalt). He was born on January 5, 1850, at Frankfort-on-Main. He studied engineering science at the Technical High School in Berlin, made rather extensive journeys in foreign countries and entered in 1887 into the services of the German Continental Gas Co. at Dessau, of which firm he was Director-General during the years 1890–1912. His technical achievements, based upon sound scientific knowledge, have been acknowledged by the bestowal of the honorary degrees of Dr.Ing. and Dr.Phil. Dr. von Oechelhaeuser contributed largely to the development of the gas industry; for example, he substituted for the old type of horizontal gas retorts, with their great amount of hand work, the vertical retorts, in which the coal glides down by its own weight and at the same time is gasified. On the other hand, he constructed the first engine on the Oechelhaeuser system, by which it became possible to use the gas from a blast furnace directly for power production. In addition to this, he was successful in raising the social standing of the engineer in Germany, in his capacity of president, during many years, of the Society of Gas and Water Engineers and of the Society of German Engineers.

Prof. Hermann Scholl, professor of technical physics of the University of Leipzig, died on June 27, aged fifty-one. His premature death will be much regretted. He was born on January 14, 1872, in Eupen, Rhenish Prussia, and studied at the Technical High School, Aix-la-Chapelle, and at the University of Giessen, where he became assistant to Prof. Otto Wiener, with whom he moved to Leipzig in the year 1899. In 1910 he was made professor of technical physics, and he organised the practical courses of this study at the university. His investigations were concerned mainly with the relation between light and electricity; for example, he was of opinion that electric action of the light plays an important part in the first-known photographic process, the daguerreotype process. Much important work was done by Scholl in his capacity as an expert of the Reichsgericht in patent cases. In numerous decisions concerning the validity of patents connected with electricity and mechanics, the senate of the supreme German court of justice followed Scholl's opinion. In consequence of his far-reaching scientific knowledge and thorough understanding of technical questions, Scholl exerted great influence upon the development of industry. Industrial circles, as well as his colleagues and pupils, will be much afflicted by the loss of this distinguished man.

We regret to announce the following deaths:

Dr. E. Beckmann, on July 12, aged seventy. An appreciative note on his life and work appeared in our issue of July 21, p. 109, when the occasion of his seventieth birthday celebrated on July 4 was recorded.

Prof. L. Hiltner, president of the Bavarian Botanical Institute, on June 6.

Prof. E. W. D. Holway, of the University of Minnesota, known for his work on the rust-fungi, on March 31, aged seventy.

Prof. F. Krafft, professor of chemistry at Heidelberg, aged seventy-one.

Dr. Josef Nevinny, professor of pharmacology and pharmacognosy at the University of Innsbruck, aged seventy.

Prof. J. P. Langlois, of the Conservatoire national des Arts et Metiers, and editor since 1910 of the *Revue générale des Sciences*, on June 17.

Dr. J. G. Rutherford, chairman of the International Commission on Control of Bovine Tuberculosis and Canadian delegate at the International Institute of Agriculture at Rome in 1908, on July 24, aged sixty-five.

Current Topics and Events.

The problems of physics are manifold, and tend to increase in number and in difficulty. Fifty years ago there was a general feeling that we had only to proceed steadily in the application of familiar dynamical principles to explain all the phenomena of inanimate nature. Some men of science would have included in such an explanation the facts of animate nature as well. How different is the position to-day! Sir Oliver Lodge, in the illuminating address which appears as a supplement to this issue, expounds the difficulties and perplexities which now face the natural philosopher, summing them up in the two words, "ether" and "electrons." The relativist may, for his own special purposes, ignore the ether, but Sir Oliver claims that as we find ourselves imbedded in ether and matter, it is necessary to take stock of our position and consider how much it is possible to ascertain as to etherial properties. The outstanding problems of our time, that of radiation on one hand and of atomic structure on the other, have been at least partially solved by the electro-magnetic theory of Clerk Maxwell and the electron theory which owes so much to his successors at the Cavendish Laboratory. But the still greater problem of relating these theories satisfactorily to one another and to the disquieting results embodied in the modern theories of quanta and relativity still awaits the revealing power of the master mind. The acceleration of an electron generates waves. In photo-electricity we find that radiation can fling out an electron with a surprising amount of energy. There is thus a remarkable reciprocal relation between light and electrons. With characteristic boldness Sir Oliver Lodge tackles the relations between radiation and matter and suggests—in the form of a question, it is true—that the actual generation of an electron by means of light is not an altogether impossible idea. The suggestion is perhaps not entirely new, but it has never been stated with such clearness and force, and deserves the serious consideration of scientific thinkers.

It is a remarkable fact that, despite the immense advances in our knowledge of bacteria as the causative factors of infective disease, the viruses of the eminently contagious exanthematic diseases have not been unmasked. The causes of measles, scarlet fever, small-pox, chicken-pox, and typhus have not been found with certainty. Naturally, a great many researches have been carried out to discover these unknown causes, and in the earlier days of bacteriology many micro-organisms were incriminated which are now known to be accidental contaminations or are accessory to the main cause. The history of investigation on scarlet fever illustrates this admirably. Cocci of diverse kinds, bacilli, and even protozoa, have been alleged to cause the disease. The most recent report comes from Italy, where it is alleged that di Cristina of Palermo and Carolia of Rome have discovered the germ of scarlet fever in the form of an ovoid diplococcus. From what we know of bacteria in disease, it is improbable that the exanthemata are due to microbes of this class. The contagiosity, the eruption, and the high degree of immunity point to a special class of diseases differing altogether from the bacterial infective processes. Hektoen (1923) has recently published an interesting historical research detailing the various attempts which have been made to transfer scarlet fever intentionally to man, and he considers it very doubtful whether this has ever taken place. This is remarkable when one considers the ease with which the disease is transmitted under natural conditions.

The Rothamsted Experimental Station is one of the Institutions to which the Empire Cotton Growing Corporation has made a grant of 1000*l.* for five years, for the development of research work likely to be of importance in relation to problems connected with cotton-growing. It is evidence of the enlightened outlook of the Corporation to research that the grant is free from any restrictions likely to hamper the progress of the work. The money will be employed in increasing the staff and equipment of the Soil Physics Department, in order that more rapid progress may be made in the study of the fundamental physical properties of soil. Special attention will be devoted to the water relationships, in view of their importance in districts where cotton is grown. The elucidation of these principles is necessary before trustworthy advice can be given to the growers, and, conversely, the practical problems that the local experts are expected to solve often present points that can only be answered after investigations in a research laboratory under controlled conditions. The function of the Soil Physics Department at Rothamsted will be to undertake these investigations as part of its study of the fundamental properties of soil. The Department will act as the headquarters of those men on study-leave who wish to discuss soil problems arising in the course of their work, and they will be provided with facilities for experimental investigations.

The Polish Physical Society was founded in April 1920, with five branch sections in Warsaw, Cracow, Lwów, Wilno, and Poznań respectively. Prof. Ladislas Natanson, of the Jagellonian University of Cracow, was the first president of the Society for the period 1920–23, and in the general assembly held in Warsaw in April last Prof. St. Pieńkowski was elected president and Prof. Natanson vice-president. The first part of the Society's Transactions, referring to the period 1920–21, has been recently issued. It is an interesting volume containing a number of important contributions. There is an obituary notice of Prof. Tad. Godlewski; Prof. Natanson's presidential address; and a number of papers: on the diffusion and scattering of light, especially in water, by Prof. Cz. Bialobrzeski; on discharge in electrodeless tubes, by Prof. J. Wierusz-Kowalski; on the spectra of iodine vapour, by Mr. Landau-Ziemecki; on the magnetic anomalies in Poland, by Prof. St. Kalinowski; on the electrometric study of radioactive fluctuations, by Messrs. Wertenstein and

Muszkat; on the equilibrium of a radiating gaseous sphere, by Mr. W. Pogorzelski. The original text is in Polish; there is, however, a French translation or résumé of every item. The Society has about 120 members, and its address is 69 Hoza Street, Warsaw, Poland. By strenuous and careful work, the Society should do much to promote the progress of physical science in Poland.

On September 17-30, the American Association for the Advancement of Science will meet at Los Angeles with the Pacific and South-western Divisions, and a number of other societies are also gathering at the same place. The path of totality of the total eclipse of the sun on September 10 passes close by Los Angeles, so many distinguished astronomers who have journeyed to the neighbourhood for observing the eclipse are expected at the meeting. According to *Science*, Section D (Astronomy) is to hold joint meetings with the American Astronomical Society and the Astronomical Society of the Pacific at the University of Southern California, at the Mount Wilson Observatory and at the California Institute of Technology. A symposium on "Eclipses and Relativity," at which Dr. W. W. Campbell, president of the University of California, Dr. C. E. St. John, of Mount Wilson Observatory, and Dr. S. A. Mitchell, of the University of Virginia, are to deliver addresses, has been arranged for the opening day of the meeting.

"Æolus," on whose letters in the *Wimbledon Borough News* we commented in our issue of June 30, p. 889, has addressed to us a further letter in which he renews his protest against the by-pass road planned alongside Beverley Brook, and bespeaks our sympathy for the human users of Wimbledon Common no less than for the other animals. Unless the whole of the Fitzgeorge estate is bought for the public (a somewhat hopeless hypothesis), there will be roads of some kind, and we are not aware of any scheme better than that which was reached by representatives of the varied interests concerned. It has, we understand, been proposed that a belt of trees shall be planted to screen the road, a practicable measure which has our full support. No excessive stream of motor cars is anticipated, and indeed our own experience of Wimbledon Common is that small boys and the scatterers of paper are more destructive of its natural peace and beauty than is any of the high-road traffic.

It is curious how often scientific announcements made in British journals are overlooked by the general Press at home, but appear later as messages "From our own Correspondent" abroad. An example of this is a message from the New York correspondent of the *Times*, published in the issue of July 30, upon the discovery, by Prof. J. B. Collip, of an insulin-like plant hormone to which he gave the name "Glucokinin." The discovery was described by Prof. Collip in Nature of April 28, p. 571. It seemed scarcely worth while, therefore, to cable from New York that it "was announced here yesterday by Prof. J. J. Wiltman, of the University of Minnesota, through the American Chemical Society," especially as Prof. Collip's own letter of three months ago provided much fuller information.

Mr. Alec Ogilvie has been elected chairman of the Royal Aeronautical Society for the year 1923–1924, in succession to Prof. L. Bairstow.

The Secretary of State for the Colonies has appointed Lieut. J. R. Stenhouse to be master of the research ship *Discovery*, which, as announced in Nature of April 21, p. 540, is to proceed to the neighbourhood of South Georgia and the South Shetlands in order to obtain scientific evidence bearing on the whaling problem.

With reference to a note in Nature (July 7, p. 19) on the work in archæology of the late Prince of Monaco, Mr. F. Fawcett writes that while the excavation of the caves and the collection of the relics are due to the Prince, the building in which they are stored was constructed through the liberality of the late Sir Thomas Hanbury of La Mortola.

The Department of Scientific and Industrial Research requires a research engineer to take charge of the Building Research Board's Experimental Station, East Acton. Candidates should be honours graduates in civil engineering, or possess equivalent qualifications, and if possible have had experience in research in building materials and construction. Applications, with testimonials, etc., must be made in writing by, at latest, August 20, to the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1.

Applications are invited for the Yarrow scholarships in connexion with the Institution of Civil Engineers. The scholarships vary in value from 50*l.* to 100*l.* per annum and are open to British subjects who, desiring to become engineers, lack sufficient means to enable them to pursue their practical or scientific training. The regulations concerning the scholarships are obtainable from the Secretary of the Institution of Civil Engineers, Great George Street, Westminster, S.W.1. The latest date for the receipt of applications is September 30.

The following awards have been made by the Royal College of Physicians: The Baly gold medal, given every alternate year to the person who shall be deemed to have most distinguished himself in the science of physiology during the two years immediately preceding the award, to Mr. J. Barcroft; the Bisset-Hawkins medal, bestowed triennially on some duly qualified practitioner, who is a British subject, and who has, during the preceding ten years, done such work in advancing sanitary science or in promoting public health as, in the opinion of the College, deserves special recognition, to Dr. T. M. Legge. The Harveian Oration on St. Luke's Day will be delivered by Prof. E. H. Starling.

In connexion with the visit of members of the Society of Glass Technology to France, during the first week of July, two meetings with French glass

manufacturers were held on Monday, July 2. In the morning the visiting party was received by the Chambre Syndicale des Maîtres Verreries, and was welcomed by its president, M. L. Houdaille, who described to the visitors how the French glass manufacturers are all united in one body—the Chambre Syndicale—which is divided into six sections representing various branches of the industry. The work of these sections is organised in such a way as to prevent ruinous competition between members, and at the same time encourages individual research and development. In the afternoon a joint meeting was held with the Société des Ingénieurs Civils, in the course of which the following papers were presented: "La Méthode Scientifique dans l'Industrie," by Prof. H. Le Chatelier; "Les Verres, Opaques et Colorés, et les Glacures Céramiques de Même Espèce," by Dr. A. Granger; "La Dilatation des Verres et Cristaux," by M. Lafon; "Specifications for Glass Products," by Prof. W. E. S. Turner; "Improvements in the Design of Recuperative Glass Pot Furnaces," by Mr. T. Teisen; and "The Physical Properties of Boric Oxide Glasses," by Mr. S. English and Prof. W. E. S. Turner. During the week, visits were paid to glass works at St. Denis, Rheims, Chantereine, St. Gobain, Chauny, and Cirey. A visit was also paid to the sand quarries at Nemours and to the forest and castle of Fontainebleau. Altogether, some thirty British members of the Society and their friends took part in the visit. Encouraged by the success of this and the visit in 1920 to America, it is proposed to arrange other tours as opportunity arises.

A MEMORANDUM regarding the probable amount of monsoon rainfall in 1923 was submitted, in the early part of June, to the Government of India by Mr. J. H. Field, officiating Director-General of Observatories. For the purpose of a forecast of the monsoon, India is divided into five sections, and the several conditions which are favourable for the various sections are given—the conditions ranging over a large part of the globe, and at different seasons of the year. It is noted that a marked feature of the weather in May was the comparative absence of temporary advances of the monsoon in the Arabian Sea, where the monsoon proper was behind time. Details are given of the influencing conditions in different parts of the globe, and from these it is concluded that there would be some delay in the establishment of normal monsoon conditions within the Indian area, but it was estimated that the delay was not likely to be prolonged. With regard to the total amount of monsoon rainfall, it seemed that in the Peninsula there should be a small excess, with a corresponding excess in Mysore and Malabar. For northern India and Burma no forecast could be issued. Recent telegraphic communications from Bombay received in the middle and towards the end of July state that the agricultural outlook is now satisfactory over almost the whole of the Bombay Presidency, where enough or more than enough rain has fallen nearly everywhere. According to usual custom a further monsoon forecast will be issued in August; past experience shows that the earlier forecast issued in June is usually on the whole the more successful.

A MURAL tablet to the memory of the great naturalists and lifelong friends—Frederick Du Cane Godman and Osbert Salvin—was unveiled at the Natural History Museum on July 28 by Lord Rothschild, and was accepted by the Archbishop of Canterbury on behalf of the Trustees of the British Museum. Upon the death in 1919 of Godman, who was for many years a Trustee and a generous benefactor to the Museum, a Committee was set up with the object of placing in the building a memorial to him and to Salvin, who had died in 1898, and it was decided to use the balance of the money collected as the nucleus of an exploration fund for the benefit of the Museum; to this Fund Dame Alice and the Misses Godman later added the sum of 5000*l*. The memorial was designed by Sir Thomas Brock, and after his death the task was completed by Mr. Arnold Wright. Godman and Salvin, both of whom were fellows of the Royal Society, will be remembered for the remarkable work entitled "Biologia Centrali-Americana," which was planned by them, and finally completed by Godman after Salvin's death. It consists of sixty-three volumes; the first forms the introduction, fifty-one deal with zoology, five with botany, and six with archæology. For the work the aid of many specialists was called in, but Godman and Salvin themselves undertook the chapters on birds and diurnal lepidoptera. The whole of their marvellous neo-tropical collection was presented to the Natural History Museum; many of the specimens they had themselves collected during their travels in Central America and Mexico. In addition, Godman's gifts to the Museum were many and valuable. The tablet hangs on the wall at the head of the main stairs in the Central Hall on the east side of the statue of Darwin.

THE Report for the year 1922 of the National Physical Laboratory extends to 227 pages and is provided with an index of 24 pages. Sufficient information is given to allow the reader to understand the methods in use at the Laboratory and to follow the advances made. The diagrams and illustrations add materially to the value of the report from this point of view. The number of tests made during the year is still on the down grade, as one would expect from the statistics of trade. The various research boards and government departments continue to depend on the Laboratory for the conduct of the investigations they initiate, but the Executive Committee has found it advisable to appoint a research committee consisting of Sirs J. J. Thomson, W. H. Bragg and E. Rutherford to assist in the organisation of research at the Laboratory. This committee has made valuable suggestions as to the future work and needs of the Laboratory. There have been few changes in the senior staff during the year, and those that have taken place are due to other government departments claiming men with special knowledge. An extension of the metallurgy building which had

been needed for some time has been completed and is now in use, but the work in the physics building is still congested.

An opportunity has been afforded us to examine and test the Hatchett planimeter and the pantograph designed and manufactured by W. H. Harling, 117 Moorgate, E.C. 2. The planimeter is very simple and compact in form: after a little practice it can be made to give results of considerable accuracy. The writer has tested it on variously shaped areas of different sizes, with good results. The pantograph is a more complicated instrument, designed on the principle of simple parallelograms, and can be set to sixteen different ratios. Geometrically, the instrument seems to be quite satisfactory. In use, however, one or two faults can be detected. First, there is not enough pressure on the pencil point to produce a useful drawing. Second, the pencil is not steady, there being insufficient constraint for keeping it perpendicular to the plane of the instrument. If these faults are remedied, the pantograph should prove very useful. Both instruments are offered at moderate prices.

The Milroy Lectures on "Canned Foods in relation to Health," which were delivered a short time ago by Dr. W. G. Savage, are to be published in the autumn, in the Cambridge Public Health Series, by the Cambridge University Press.

Messrs. J. and A. Churchill are about to publish "Clouds and Smokes: the properties of disperse systems in Gases," by Dr. W. E. Gibbs, in which will be described the various ways in which disperse systems in gases can be formed; their mechanical, thermal, optical, and electrical properties, and the conditions which determine their stability are discussed. This information is then applied to the practical problems of meteorology, fume condensation, gas filtration, the manufacture of substances in a finely powdered condition, and the use of smoke in warfare.

Our Astronomical Column.

The Great Perseid Meteor Shower.—Mr. W. F. Denning writes: "The maximum of the Perseids occurred in 1921 on the morning of August 12, and the earth may be expected to be in the same position of its orbit in the early afternoon of August 12 next. There may therefore be no very rich shower, though one may possibly recur in Japan and in the East.

Our acquaintance with the distribution of the Perseids is, however, by no means perfect, and it is fairly certain that a fairly good display will be observed in England this year if the weather allows suitable observations to be made. The moon being new at the time of the maximum will be a favouring feature.

Observations should be made on the early morning of August 12 and during the night following that date. The hourly number of meteors should be counted, and the apparent paths among the stars of the larger ones should be accurately recorded so that their real paths may be computed.

It will be interesting to note if there are any strong displays of the minor radiants of this period, such as the Cepheids, Cygnids, Lyrids, or Arietids."

Observations of Jupiter.—*L'Astronomie* for July contains three drawings of Jupiter on April 24 and May 1 by M. Pierre Feurtey, using an equatorial of 0·19 metre aperture screened down to 0·14 metre. The Red Spot, the tint of which is described as *saumon gris*, seems to have revived since last year, as it is shown quite strongly marked in the drawing of May 1, with two lighter patches in its interior, and the surrounding bays, both north and south, very dark. A row of six round white markings follows the spot, slightly to the north of it.

Several narrow dark bands cross the light equatorial zone obliquely.

Parallaxes of Fifty-seven Stars.—The Memoirs of the National Academy of Sciences (Washington), vol. xix., contains the results of the determination of the parallaxes of fifty-seven stars made by Mildred Booth and Frank Schlesinger. In twenty-two of these no previous determinations of parallax have been made. The authors point out that, without the co-operation of several institutions, a long interval would have elapsed before these results could have been made available. Thus the photographic plates were secured with the Thaw photographic refractor of the Allegheny Observatory: the measures and reductions were completed at the Yale Observatory under a grant from the National Research Council (Division of Physical Sciences) to the committee on Stellar Parallaxes of the American Astronomical Society. The measuring machine was purchased several years ago with a grant from the Draper Fund of the National Academy of Sciences. The measurements and computations were carried out by Miss Booth, the methods employed having been previously published. The average number of comparison stars used was 3·8, and the average number of plates for each region was 15. It is interesting to note that a great many of the stars in the list are double; thus nearly every object is one of more than average difficulty, the stars having in fact been selected on that account from a long list awaiting attention at Allegheny. A summary of the parallaxes is given in a table showing the visual magnitude and spectrum type, total proper motion, relative parallax and probable error, and finally, the probable error for one good plate.

Spectroscopic Binaries.—The Dominion Astrophysical Observatory, Victoria, is determining orbits for a number of these binaries. The chief interest in this research is the material for determining the average mass of stars of each spectral type. The masses of individual stars are indeterminable owing to the uncertainty of the inclination, but in studying a large number of binaries we may assume that the inclinations follow the law of random distribution. The elements of the following three stars have lately been determined:

	Spectral Type.	Period.	Mass in terms of sun's mass.
BD 44° 3639	Oe 5	48·608 days	0·374
Boss 4870	B 2	1·0309 ,,	0·00019
ϕ Aquilae	A 2	3·3204 ,,	0·0192

The first is of special importance, since few masses of this type are known. One spectrum only is visible in each of these cases, so the companion is likely to have smaller mass. In the Oe 5 spectrum, the sharp H and K lines do not share in the oscillations and give a velocity of −11·3 km./sec., as compared with −5·8 km./sec. for the centre of gravity of the system.

Research Items.

TONGAN ASTRONOMY AND THE CALENDAR.—In one of the Occasional Papers of the Bernice Pallahi Bishop Museum (vol. viii. No. 4, 1922) Mr. E. E. V. Collocott has collected all that can be known of Tongan astronomy. They had the vaguest notions of the heavens and of the relations of the sky to stars, sun, and moon. They treated astronomy as a branch of navigation, but since the use of the mariner's compass, few if any living Tongans are able to point to or name more than a very small proportion of the stars. Practically all the available star lore of the Tongans is included in sailing directions written by the late Tukuaho, who was Premier of Tonga about thirty years ago, and this account, copied by permission of his son Tungi, consort of H.M. the Queen of Tonga, has been followed by Mr. Collocott in compiling this paper.

DISCOVERY OF AN EARLY PALÆOLITH IN NORFOLK.—In the *Antiquaries Journal* for April (vol. iii., No. 2), Mr. J. Reid Moir describes the discovery by Mr. J. E. Sainty of an Early Palæolith from the Glacial Till at Sidestrand, Norfolk. The specimen contains, in its interstices, material which, in appearance, is identical with the matrix of the Boulder Clay, and the colour of the flake-scars is precisely similar to the broken surfaces of many flints in the Till at Sidestrand. Mr. Reid Moir believes that the implement originally belonged to the Upper Freshwater Bed, the highest division of the Cromer Forest Bed Series. The Early Palæolithic implements of these strata are believed to afford the only evidence in East Anglia of the warm climate prevailing in Early Palæolithic times, and possibly representing the Günz-Mindel interglacial epoch. This gives definite evidence that the manufacture of early Chellean hand-axes was begun in what is now East Anglia, before the arrival of the glaciers which were responsible for the deposition of the Lower Glacial beds. Mr. Sainty has generously presented this Sidestrand implement to the Ipswich Museum.

CHROMOSOME MOVEMENTS IN NUCLEAR DIVISION.—Many attempts have been made to explain the forces at work in connexion with the mitotic figure in nuclear division. Attractions and repulsions are evidently involved, and these may result partly from the presence of electrical charges on the colloidal particles. The latest contribution to this subject is by Mr. Graham Cannon (*Journ. of Genetics*, vol. 13, No. 1), who applies Lamb's hypothesis that the centrosomes are pulsating or oscillating bodies, and also extends it to a consideration of the movements of the pronuclei in fertilisation. Mr. Cannon discusses many of the consequences which would follow from this assumption, but as yet there is little direct evidence that the centrosomes are actually centres of oscillation or pulsation. A very interesting feature included in the paper is the demonstration, by means of figures of the chromosome groups in the equatorial plate of various animals, that the chromosomes do in fact arrange themselves like floating magnets, the particular arrangement depending upon the number of bodies present. This result was predicted by R. S. Lillie in 1905.

EFFICIENCY IN COTTON WEAVING.—As the number of studies made in different industries and in different departments of the same industry increases it becomes more and more apparent that there are conditions militating against efficiency which are of an alterable character. A careful study of efficiency in cotton weaving, by Mr. S. Wyatt (Reports of the Industrial Fatigue Research Board, No. 23; London: H.M. Stationery Office, price 3*s.* net), demonstrates once more the value of natural, as against artificial, illumination; this factor has been shown in previous reports to hold true in silk weaving and in fine linen weaving. The relations between humidity, high temperatures, and efficiency are very well brought out; under existing conditions it is maintained that the best conditions for productive efficiency in weaving, in humid sheds of the type investigated, seem to be with a dry bulb temperature of 70°-75° F. and a relative humidity of 80-85 per cent. The writer also shows that, on the two-break day system, the efficiency during the pre-breakfast spell is consistently low. Various other aspects of the problem are considered, such as personal ability, individual differences, incentives and fatigue, and suggestions are given both for the amelioration of the conditions of the cotton weaver and for further study. The Fatigue Research Board in its cautious preface to the report is careful to point out the limits within which the conclusions must be interpreted. It is interesting, though, to note that in considering one report after the other there is a rapidly increasing weight of evidence in quite definite directions.

THE CONTROL OF THE PADDY STEM BORER IN INDIA.—In Memoirs of the Dept. of Agriculture in India, Entomological Series, vol. vii. No. 13, 1923, Mr. E. Ballard gives an account of experiments on the control of the paddy stem borer *Schœnobius incertellus* in the Godaveri delta. The insect occurs wherever paddy is grown in the East, and causes an annual loss of 10 per cent. of the entire Indian crop. Various schemes have been put forward for controlling the insect, the use of light traps being largely advocated. Mr. Ballard expresses doubts as to the efficacy of the latter method. Such traps are expensive and liable to be stolen, sometimes they only attract moths towards the light without destroying them, while many of the moths have laid their eggs before being trapped. The method of selecting attacked seedlings at the time of transplanting gives some hope of constituting an effective means of control. Close cutting, used in combination with seedling selection, should also destroy a large proportion of the larvæ from which the succeeding crop could be infected. The extent to which stubble helps the insect to tide over the time between the crops needs research. The natural insect parasites of the borer also require study, and the possibility of growing immune varieties of paddy should be tested.

CORRELATION OF OIL-SANDS: THE DAKOTA GROUP.—The correlation of oil-bearing sands on the basis of palæontological or petrographical work or both, is a phase of the geology of petroleum which has not always received the detailed attention in the United States that it undoubtedly merits. It is therefore gratifying to note that the importance of such work is now more generally realised, and Mr. W. T. Lee's contribution to Bulletin 751 on the "Continuity of some Oil-bearing Sands of Colorado and Wyoming" is a case in point. As Mr. Lee remarks, nearly every important sandstone in the great Cretaceous system of the western states contains oil, and the differentiation and correlation of these oil-horizons form problems the ultimate solution of which is demanded before this vast region can be economically developed. The rocks dealt with in this report belong principally to the Dakota Group, and apart from valuable local details regarding the different sands and shales

included, the author establishes the important stratigraphical fact that there is no single, definite, persistent and easily recognisable sandstone corresponding to the formerly so-called Dakota Sandstone, but that a group of sediments to which the name Dakota is given represents successive accumulations of sediments near the strand-line of an advancing Cretaceous sea, presumably Upper Cretaceous, but not necessarily so. Hence the group differs in age from place to place according to the time taken by the advance of this strand-line across intervening distances.

WEATHER AT FALMOUTH IN 1922.—Falmouth Observatory has recently issued meteorological notes and tables for the year 1922, prepared by Mr. J. B. Phillips, superintendent of the Observatory. The mean barometric pressure for the year was 29·96 in., which is 0·02 in. below the normal. The mercury reached a maximum height of 30·79 in. during November, which is also the highest November reading on record since the commencement of observations in 1871. The high-pressure system associated with this reading prevailed from November 10 until December 15. In July the barometer fell to 28·98 in., which is the only record with the barometer below 29 in. in July. Temperature reached its highest reading, 75° F., on May 31, and the minimum, 28° F., on March 23. The summer was cool, the day temperature registering 70° F. or above on 6 days only, 4 in May and one in June and September respectively. Bright sunshine for the year registered 1663 hours, which is 90 hours less than the normal; the brightest month was May with 260 hours of sunshine, and the least sunny was December with 48 hours. Rain fell on 211 days, yielding a total of 45·75 in., which is 0·14 in. more than the normal. December, which is normally the wettest month of the year, had the highest monthly rainfall, amounting to 8·02 in., of which 7·64 in. fell in the last 16 days. During the year the equability of the climate of Falmouth withstood two severe tests. In an exceptionally cold period at the beginning of April, of 108 stations in the British Isles it was one of 9 at which the temperature did not fall below 34° F., and during a hot spell from May 21 to 24, when temperatures above 80° F. were general on the coast, the maximum did not rise above 68° F.

COMMERCIAL PRODUCTION OF OXYGEN.—The *Chemical Trade Journal* for June 15 contains an account of a long paper by Mr. T. Campbell Finlayson on "Industrial Oxygen," which was read before the Institution of Chemical Engineers. The aim of the work was to find a means of producing oxygen industrially at a price of 1*s.* per 1000 cu. ft. This was not realised, but a large number of possible methods were tried, some of which were found to be quite practicable. Chemical methods are impossible, as they are invariably too expensive; the most promising method is based on the differential solubility of oxygen and nitrogen under pressure in different liquids. Mr. Finlayson remarked that the discovery of a more suitable solvent might put the matter in a very different light. It will be recalled that this method was used, with water as a solvent, by Mallet half a century ago.

RECORDING WATER-LEVELS ELECTRICALLY.—A new form of electric transmission, for long-distance indication of variations in water-level and similar purposes, has been devised and put on the market under the designation of the Telechron Transmitter. The drawback in regard to systems of electric transmission in such cases is that dependence has to be placed on the unfailing action of the receiver to record the series of impulses sent out from the transmitter. With the ordinary electro-magnetic apparatus, owing to difficulty in exciting the magnetic field with sufficient promptitude, there is a possibility of failure to transmit signals which succeed one another rapidly. In other words, the receiver and transmitter are liable to "get out of step." In the Telechron instrument, signals are transmitted at a constant rate, independent of the speed of movement of the float or other actuating agent; the impulses are accumulated by the transmitter and are despatched in sequence at a rate within the capacity of the receiver to record them. It is thus possible for a float to make a rapid rise without the omission in the recorder of any one of the impulses in the series generated. Falls in level are equally accounted for, and when alternations take place rapidly the instrument records the net difference in either sense. It is possible to store up any number of impulses in the transmitter, though for practical purposes it is only necessary to provide for a hundred revolutions of the counter. Should the circuit by any chance be broken or the battery fail, the transmitter automatically sets itself and the receiver in step on the restoration of the current. There are other possible applications of the Telechron besides the long-distance record of water-levels; it is a trustworthy telegraph to indicate the position of a ship's helm, or of a lock-gate, or other moving object. It can also be adapted to the purpose of recording the pressure in gas mains. The apparatus is introduced by the Telechron Electric Transmitter Company, of 53 Victoria Street, S.W.

LUMINESCENCE.—Luminescence, as defined by Wiedemann, includes all cases of radiation except those due to temperature alone. In this sense the term is used in the valuable report published as a Bulletin of the National Research Council of the United States, entitled, "Selected Topics in the Field of Luminescence." The report, which is the work of Prof. E. Merritt, E. L. Nichols, and C. D. Child, covers a wide range, but most of the topics chosen for discussion are connected with fluorescence and phosphorescence. Prof. Merritt, who is responsible for the greater part of the volume, contributes an important chapter on theories of luminescence, dealing with the work of Lenard, Kowalski, Kennard, Baly and Perrin. A perusal of this chapter confirms the opinion that the most important problem at the present time in the field of luminescence is that of developing some satisfactory and comprehensive theory which may serve as an aid in correlating the observed phenomena and as a guide in planning new investigations. Such a theory must link together the varied subjects dealt with in later chapters—luminescence at high temperatures, luminescence and photo-activity, and, in particular, fluorescence and chemical change. Special attention may be directed to the work of Pringsheim, who, after a somewhat extended discussion of photochemical theories of fluorescence, is inclined to decide against such theories, putting forward certain suggestions in explanation of the chemical changes that so often occur in connexion with fluorescence. In the bibliography of luminescence, forming the last chapter of the report, Dr. J. A. Becker has made a serious attempt to include references to all books and articles on luminescence that have appeared between the years 1906 and 1922. References to papers on spectroscopic work have been included when, as in the case of flame spectra, they appear to have a direct bearing on the theory of luminescent radiation.

The Electron in Relation to Chemistry.

THE Faraday Society's conference on "The Electronic Theory of Valency," held at Cambridge on July 13 and 14, may be regarded as marking a new stage in the welding together of physics and chemistry, which has been so notable a feature of the recent history of these two sciences. The conference was attended by about 120 delegates from different universities, about half of whom were drawn from outside Cambridge. Some forty visitors were entertained in Trinity Hall, through the kindness of the master and fellows, to whom a deep debt of gratitude is due for contributing in this way to the pleasant social features of the conference. The foreign guests included Prof. G. N. Lewis, Prof. W. A. Noyes, Prof. Lyman, and Prof. Victor Henri of Zurich; the physicists included Sir J. J. Thomson, Sir Ernest Rutherford, Sir William Bragg, Prof. Barton, Prof. W. L. Bragg, Prof. Porter, Prof. Rankine, Dr. F. W. Aston, and Mr. R. H. Fowler; the chemists, in addition to Sir Robert Robertson, the president of the Faraday Society, included Sir William Pope, Prof. Heilbron, Prof. Lapworth, Prof. Lowry, Prof. Robinson, Prof. Smithells, Prof. Thorpe, Mr. C. R. Bury, Dr. Flürscheim, Dr. W. E. Garner, Dr. Henstock, Dr. Kenner, Mr. W. H. Mills, Mr. E. K. Rideal, and Dr. N. V. Sidgwick.

The conference was held in the new Department of Physical Chemistry, which is housed very appropriately in a block of buildings lying between the Chemical Laboratory in Downing Street and the Cavendish Laboratory in Free School Lane. These buildings, which were formerly in the occupation of the Department of Engineering, now provide ideal quarters for work in physical chemistry. They have been completely refitted and are admirably suited to their new use; they are also so commodious that there is a reserve of floor-space which has been loaned to workers from other departments, pending the time when it may be required for further extensions of physico-chemical work. Tea was served before the conference opened, in the large laboratory of the Hopkinson wing, which was erected in 1900 as a memorial to the late Prof. Bertram Hopkinson and his son, while the discussions were held in the lecture theatre adjoining.

The Friday afternoon session, dealing mainly with the application of the electronic theory to the problems of inorganic chemistry, was presided over by Sir J. J. Thomson, who in his opening address referred to the fact that, while the force which retains the electrons in an atom is proportional to the positive charge on the nucleus, the disruptive force which tends to make them scatter is proportional to the third power of their number, so that a limit is set to the number of electrons which can be crowded into one atom. The law of force is such that when the number of electrons is small, the octet is a particularly stable grouping; but with a different law of force, a sextet might be more stable than an octet. The problem of molecular structure can be attacked most readily by the study of cases of substitution; thus the electric moment introduced on replacing hydrogen by chlorine can be calculated, and measurements of the specific inductive capacity of molecules of different types have shown that this moment is constant in magnitude.

Prof. G. N. Lewis, in presenting his paper on "Valence and the Electrons," directed attention to the reconciliation which has recently taken place between the views of physicists and chemists in reference to the structure of the atom. Since physicists have now adopted a model in three dimensions, it is possible to regard the orbit of the electron as having a fixed orientation, although the electron itself is in rapid motion. The chemist's theory of static electrons has, therefore, been merged quite naturally into a scheme of static orbits. Prof. Lewis directed attention to the fact that, in Bohr's atomic structures, each of the rare gases from neon to niton, and all the stable elementary ions, possess eight electrons in the outer shell, thus affording full justification for what came to be known as "the octet theory." The fundamental phenomenon of chemistry is, however, the formation of *pairs* of electrons; and of some hundred thousand known substances only about half-a-dozen contain uneven numbers of electrons. This pairing may perhaps be due to magnetic forces, since unpaired electrons always give rise to a magnetic moment. When four of these electron-pairs are grouped at the corners of a regular tetrahedron the still more stable configuration of the octet is obtained.

Prof. Lewis attaches great importance to the view that the sharing of a pair of electrons constitutes a chemical bond between two atoms. When this bond is broken, the electron-pair usually remains attached to one atom, which acquires a negative charge, while the associated atom (which loses its share of the electron-pair) acquires a positive charge on disruption. This contrast is described in Langmuir's nomenclature as the conversion of a "covalence" into an "electrovalence"; and most English readers have accepted this nomenclature as an essential feature of the "Lewis-Langmuir hypothesis." Prof. Lewis, however, regards the ionised bond as being no longer a bond at all, and even objects to the use of the term "valence" to express the electrical state of the atom, although for nearly seventy years bismuth and aluminium have been described, like phosphorus and nitrogen, as tervalent elements.

The two following papers, by Mr. R. H. Fowler on "Bohr's Atom in Reference to the Problem of Covalency" and by Dr. N. V. Sidgwick on "The Nature of the Non-polar Link," were of interest as exhibiting two parallel lines of thought in the application of Bohr's theory of the structure of atoms to the unsolved problem of the electronic structure of molecules. The close agreement between the conclusions reached on this subject at Oxford and at Cambridge is noteworthy. As might perhaps have been anticipated, the Cambridge physicist was much more apologetic than the Oxford chemist, since he evidently realised more fully the risks that must be taken when forsaking the mathematical concepts, verified by observations of spectra, on which the structure of the atom is based, for purely qualitative conceptions of molecular structure, which are at present beyond the range of mathematical analyses and of experimental verification. The chemist, on the other hand, boldly translating the shared electrons of Lewis into shared orbits (compare Dr. N. P. Campbell's letter in NATURE of April 28, p. 569), was ready at once to gather a harvest of new conceptions from this speculative extension of Bohr's theory. A study of the printed papers shows, however, no important discrepancies between the views of the two authors as to the results of extending the theory of orbits from atomic to molecular structure.

In the discussion following upon the reading of these papers, Sir J. J. Thomson pointed out that two electrons are not necessary to make a bond, since H_2^+ is one of the most persistent aggregates met

with in positive rays, although there is only one electron left to hold the two protons in combination. To this Mr. Fowler replied that although this may be stable for an indefinite period in a vacuum, aggregates of this type appear to be quite incapable of resisting chemical combination—perhaps because an odd electron passing from one nucleus to the other would impart an electrical charge alternately to one atom and the other, giving rise to an unstable condition which would be particularly ready to undergo chemical change.

Prof. W. A. Noyes, after reviewing briefly the history of the development of the theory of ionisation, laid stress on the fact that the distinction between polar and non-polar union is one of degree and not of kind, the fundamental factor in both types of union being the pairing of electrons. He also directed attention to the fact that the elements, such as lithium, sodium, potassium, rubidium, and cæsium, which are monoatomic in the gaseous condition, are exactly those which have a single valency-electron in the outer shell.

Sir William Bragg made an important statement in reference to the lengths of the carbon chains in the fatty acids and esters. Each additional carbon atom in the alcohol radical increases the length of the carbon chain by 1·22 Å.U.; but for the acid radical the average increment is only 0·97 Å.U. This remarkable result can be explained, while maintaining a fixed distance of 1·5 Å.U. between the carbon atoms, by assuming, on the alcohol side of the molecule, a simple zigzagging of the chain of atoms, with a fixed tetrahedral angle of 109° 28′, the branching of the chain being to the left and right alternately. The increment on the acid side of the chain can be explained by assuming the formation of a zigzag chain of another type, the deflexions being in the order LLRRLL, etc., instead of LRLRLR. These two forms of zigzag appear to be initiated by the two types of oxygen-linking in the –CO.O– group, and then to be rigidly maintained in the two chains. The structure suggested on the acid side of the molecule may explain the alternation of physical properties observed in the well-known odd and even series of acids, since the increment of length is alternately parallel to the chain and inclined at an angle of 109° 28′ to it.

At the close of the session Prof. Victor Henri made a brief communication in anticipation of the important paper which he delivered on the following day. The discussion took place under tropical conditions, which were so extreme that the session was adjourned before the discussion had become completely informal. An informal discussion was, however, carried on in the cooler atmosphere of the evening in the fellows' garden of Trinity Hall, to which some sixty delegates adjourned after dining together in the Hall of the College. The bringing into direct personal contact of workers who had previously known one another only by correspondence, or by reading one another's published communications, was a most valuable feature of the conference, and full advantage was taken of the opportunities thus presented.

The discussion, on Saturday morning, of the applications of the electronic theory of valency to organic chemistry, was presided over by Sir Robert Robertson. In opening the discussion, Prof. Lowry urged that the electron has come to stay, and that sooner or later organic chemists must take into consideration the electronic structure of atoms and molecules. These may prove to be a mere translation into a new language of the structural formulæ of Kekulé and van 't Hoff; giving rise to a new nomenclature but to no new conceptions. This is, however, unlikely in view of the enormous advances that have followed from the discovery of Dalton's atom, and of each fresh detail of its structure. The electronic theory of valence has already made a contribution of real value by discriminating between two types of valency, since a single bond can now be classified as depending either upon electron-sharing or upon electron-transference. Prof. Lowry's own contribution had consisted in the suggestion that a double bond may assume a form in which one linkage of each type is present. This has led to a number of novel conclusions which have been set out in a paper published in the April number of the Journal of the Chemical Society and in a paper on "Intramolecular Ionisation in Organic Compounds" contributed to the present discussion.

In summarising a second paper on "The Transmission of Chemical Affinity by Single Bonds," Prof. Lowry raised the question as to how many types of valency the chemist would wish the physicist to provide, and how many different mechanisms must be invented to account for the transmission of chemical affinities through chains of atoms. Prof. Lowry believes that only two types of valency are necessary, and that principal and subsidiary valencies, partial valencies, conjugated double bonds, carbonium bonds, mobile hydrogen atoms, centric bonds and paralinkages in aromatic compounds, are all manifestations of those electrostatic forces which Langmuir describes as electrovalence. In the same way, the unidirectional "general" effect, and the "alternating" effects observed in conjugated chains, appear to account for nearly all the phenomena observed in the transmission of chemical affinity. Lapworth and Flürscheim have suggested cases in which alternating effects appear to be produced in chains of single atoms; but other explanations (such as the steric effects described by Sir William Bragg) appear to be capable of accounting for most of these observations, and further evidence is needed before a third mechanism of transmission need be admitted. The evidence now brought forward by Lapworth and Robinson may perhaps provide the unexplained residue of observation which would make such a mechanism necessary. Prof. Lowry's paper also contained a vindication of Vorländer's view that, when its direct neutralising action is eliminated, the amino-group possesses well-defined acylous properties; it is therefore no anomaly for an amino-acid to be stronger than the fatty acid from which it is derived.

Prof. Lapworth, in communicating a paper on "Some Recent Contributions to the Theory of Induced Alternate Polarities in a Chain of Atoms," described six different theories which have been put forward in order to account for these phenomena. In criticism of the previous speaker, he stated that he himself twenty years previously emphasised the tendency of organic compounds to assume a "homogeneous" in place of a "heterogeneous" distribution of valency. This is precisely the same phenomenon that Prof. Lowry discussed under the heading of "Crossed Polarities." As evidence of alternate polarities in chains of atoms held together by single bonds he quoted the biochemical oxidation of butyric acid to β-hydroxybutyric acid and then to aceto-acetic acid. This case has also been quoted independently by Robinson.

Prof. Robinson contributed a paper on "Octet Stability in Relation to Orientation and Reactivity in Carbon Compounds." He directed attention, as Prof. Lapworth had done, to the fact that optical activity is often preserved in chemical changes,

although, if the intermediate stages are those which are conventionally postulated, the optical activity must necessarily disappear, since the intermediate product would be symmetrical. The preservation of asymmetry can, however, be explained by means of partial valencies, through which the asymmetry of one atom is maintained until it has been stabilised again either in the same atom or in a different one.

The bearing of the theory of polarity on the reactivity of organic compounds was discussed by Mr. E. K. Rideal, and, as illustrating this aspect of the problem, Mr. R. G. W. Norrish described some experiments which he has just carried out, according to which the union of ethylene and bromine is almost stopped by enclosing the mixed gases in a vessel lined with paraffin wax, whereas in contact with the polar surface of a glass vessel combination takes place rapidly.

In the general discussion, to which about a dozen different speakers contributed, Prof. J. F. Thorpe urged that the theory of polarity "explains everything but predicts nothing," in marked contrast to van 't Hoff's stereochemistry, which made organic chemistry into the most exact of all the sciences. This contention was strenuously denied by Mr. Burkhardt from the Manchester laboratory and by Profs. Noyes, Lapworth, Heilbron, and Robinson, who proceeded to put on record two definite predictions in order to get over the difficulty that under normal conditions the prediction and the verification are published together, so that the reader cannot be quite certain which really came first. Dr. Flürscheim also replied in a very vigorous manner to the criticisms by Prof. Lowry of his views in reference to the influence of substitution on the strength of carboxylic acids, and urged that in several examples the formation of internal salts, which had been suggested as an alternative explanation by Prof. Lowry, cannot in fact take place. Prof. Lewis directed attention to the fact that the breaking of a double bond does not necessarily get rid of *cis* and *trans* isomerism, even if free rotation can take place; and in support of this view Mr. Bury quoted the fact that quadrivalent sulphur compounds retain their optical activity even when one of the four groups is ionised.

In the final session of the conference, Prof. Victor Henri presented a paper on "Molecular Polarity deduced from the Study of Absorption Spectra." This proved to be a most remarkable contribution, in which the application of considerations based on the quantum theory led to the conclusion that quantified motion may occur in electrons, atoms, or molecules, giving rise to broad absorption-bands, narrow absorption-bands, and a fine structure of these bands, respectively. By making use of a source of continuous ultra-violet light, Prof. Henri has been able to study the fine structure of the absorption bands of a large number of compounds, and in some instances to measure as many as two thousand bands in the fine structure. A large number of photographs were shown to illustrate the various types of absorption spectra. Prof. Henri's paper produced a very profound impression by the masterly character both of the theory and of the experiments which he described. It may well mark a new era in the history of absorption spectra. In apologising to Prof. Henri for the fact that the late hour did not allow of an opportunity for discussion, the president added that the question of holding a general discussion on absorption spectra is already under consideration by the council of the Faraday Society, and that such a discussion would allow of a fuller consideration of the view which Prof. Henri had put forward.

International Conference of Phytopathology and Economic Entomology.

THE first International Conference of Phytopathology and Economic Entomology was held in Holland on June 24-July 2 by the kind invitation of the Netherlands Government in co-operation with the authorities of the various laboratories and institutes conducting work on agricultural phytopathology and entomology. The Conference was noteworthy as being the first occasion on which phytopathologists and entomologists from all countries have been invited to meet together to discuss matters of mutual interest. Prof. H. M. Quanjer of Wageningen, presided over the Conference, while Dr. L. O. Howard, Chief of the United States Bureau of Entomology, acted as president of honour. Upwards of 65 members attended—in addition to the Dutch participants—representing some 26 countries. A report of the Conference, giving an account of the demonstrations, papers read, etc., will be issued by the Committee of Management (obtainable from the Secretary, Mr. T. A. C. Schoevers, of the Netherlands Phytopathological Service, Wageningen), but in the meantime the following brief account may be of interest.

Members assembled at Wageningen on June 24, when an address of welcome was delivered by Prof. Kielstra, Rector Magnificus of the University. On the following morning the Conference was formally opened by H.E. the Minister for Home Affairs and Agriculture, and during the day members attended the inauguration, by Jonkheer van Citters, of the new Laboratory for Potato Research in which Prof. Quanjer's Department is now housed. In the laboratory and adjoining experiment station experiments of great interest, notably in connexion with the "virus" diseases of the potato, were inspected. After spending two days in conference, the members divided into two parties, one visiting Groningen and the other Boskoop, Aalsmeer and Haarlem. The first party inspected the practical application of Prof. Quanjer's experiments in the selection fields and farm of Dr. O. Botjes, who demonstrated his methods of obtaining "seed" potatoes on a large scale entirely free from virus diseases, and the second visited nurseries producing ornamental plants, shrubs and bulbs; at Lisse (near Haarlem) they visited Dr. van Slogteren's new laboratory for the study of bulb diseases, and were treated to an excellent address and to demonstrations. The two parties combined forces again at the laboratory of Prof. Westerdijk, Director of the W. C. Scholten Phytopathological Laboratory at Baarn, where the final papers were read and the discussions concluded. Subsequently H.E. the Minister for Home Affairs and Agriculture held a farewell reception at the Hague, and members were entertained to dinner at Scheveningen. Many members remained until the following week to take part in an expedition to the glass house district of the Westland.

Within a short space it is impossible to do justice to the papers read. Two subjects were, however, specially prominent—namely, (1) the research, both botanical and entomological, which centres round the

plant-diseases of the "virus" type, and (2) the efficiency or otherwise, of controlling the spread of insect and fungus pests from one country to another by means of a phytopathological service.

Discussions on the latter concerned chiefly plant import regulations and quarantines, the point of view of the exporting country being ably expounded by Mr. van Poeteren, who is director of the Netherlands Phytopathological Service. The controversial and difficult nature of this subject is well known, and it is satisfactory to record that the following resolution was approved:

"The representatives of all nations assembled at the International Phytopathological Conference at Wageningen, June 25-30, 1923, desire to place themselves on record as in full agreement with the essentials of international trade and commerce in living plants and plant-products, namely, reasonable freedom from all insect-pests and plant-diseases of all kind of materials imported into or exported from any country."

It should also be mentioned that so greatly impressed were members with the results of the Conference in bringing about international sympathy and co-operation as to the control of diseases and pests, that it was considered imperative that similar conferences under the same title should be held in future, and a small committee, under the chairmanship of Prof. Quanjer, with Mr. Schoevers as secretary, was appointed to undertake provisionally the duties of arranging for the next conference and of dealing with the various resolutions which had been passed.

This brief summary would be incomplete if some reference were not made to the hospitality and kindness experienced. Special mention must also be made of the admirable manner in which Prof. Quanjer carried out his duties as president, and the debt members owe him for rendering the discussions clear to all by rapid translation. As secretary, Mr. Schoevers was untiring, working literally night and day for the good of the Conference.

Sir William Thiselton-Dyer.

TRIBUTE FROM BRITISH BOTANISTS.

On July 28 Sir William Thiselton-Dyer attained his eightieth birthday and was the recipient of the subjoined letter from botanists throughout the country. Sir William's work as assistant director of the Royal Botanic Gardens, Kew, under Sir Joseph Hooker, and then as director for a memorable period of twenty years, is so well known that it is not necessary to refer to the many important things he did during his term of office. The present condition of the Gardens, and the prestige of Kew all over the world, are sufficient testimony to his ability and prescience. We beg to extend to Sir William in his retirement our congratulations and best wishes that he may long continue to enjoy his health and carry on his botanical activities.

Dear Sir William,

The occasion of your eightieth birthday affords us the opportunity of which we gladly avail ourselves, not only of offering you our congratulations upon having attained so venerable an age, but also of assuring you of our continued regard and esteem. In doing so we who sign this letter do but acknowledge our indebtedness to you for the inspiration and guidance which we, both as teachers and researchers, have derived directly or indirectly from your own early work as a professor of botany. We regard that work, and more especially the courses of practical instruction conducted by you at South Kensington in the years 1875 and 1876, as having inaugurated the renaissance of the study of the structure and functions of plants which had been so brilliantly carried on by British botanists in earlier times. It must, we feel sure, afford you great and justifiable satisfaction to contemplate the marvellous development of such studies in this country during the years that have passed since you quickened them into new life.

The professorial career on which you had embarked so brilliantly was unfortunately, as it may have seemed at the time, brought to a close by your appointment to the assistant directorship of Kew in 1875 and your subsequent appointment as director ten years later. The work that you were enabled to carry out at Kew has been of such national importance, that, however much we may regret the loss of the stimulating influence you would undoubtedly have exerted as a professor, we all realise the great and lasting services you have rendered to botany, not only from the purely scientific point of view, but also in relation to the development and encouragement of botanical enterprise throughout the British Empire.

Another notable result of the interest you inspired was the successful launching of the *Annals of Botany*, which has come to be one of the leading botanical periodicals of the world. We do not forget that it was your enthusiasm that turned the scale when the question of "to be or not to be" hung in the balance. The *Annals* is a lasting monument to your courage and prescience.

It would need a lengthy document were we to attempt to set out in detail the value of your many efforts for the promotion of our science, but in conclusion we feel we must refer to the noble work you did in saving the old Chelsea Physic Garden from destruction. Thanks to you, London has now a botanic garden where students and teachers can study the structure and functions of plants and pursue those studies which you did so much to promote.

With our very kind regards and good wishes,

Believe us to be, dear Sir William,

Yours very truly,

D. H. Scott	F. Keeble
S. H. Vines	A. B. Rendle
F. O. Bower	A. Shipley
Balfour	H. Wager
H. T. Brown	F. F. Blackman
D. Prain	V. H. Blackman
F. Darwin	F. W. Oliver
H. H. Dixon	A. G. Tansley
A. C. Seward	F. E. Weiss
J. B. Farmer	A. W. Hill

and all the leading botanists in Great Britain and Ireland.

University and Educational Intelligence.

Edinburgh.—At a special graduation ceremonial, held in the University Library Hall on July 25, the following members of the eleventh International Physiological Congress, then meeting in Edinburgh, were presented to the vice-Chancellor (Sir Alfred Ewing), by Sir E. Sharpey Schafer, for the Honorary LL.D.:—Prof. F. Bottazzi, professor of physiology, University of Naples; Prof. W. Einthoven, professor of physiology, University of Leyden; Prof. W. H. Howell, professor of hygiene, Johns Hopkins University, Baltimore; Prof. J. E. Johansson, professor of physiology, University of Stockholm; Prof. A. Kossel, professor of physiology, University of Heidelberg; Prof. H. H. Meyer, professor of pharmacology, University of Vienna; Prof. I. P. Pawlow, professor of physiology, University of Petrograd; and Prof. C. Richet, professor of physiology in the Faculty of Medicine, Paris.

London.—Dr. Lydia Henry has been appointed Warden of the Household and Social Science Department, King's College for Women, Campden Hill Road, W.8.

Manchester.—The Empire Cotton Growing Corporation has recently offered to the University, for a period of five years, a grant to promote study and research in mycology and entomology, more particularly the diseases of plants caused by animal and fungal parasites known to be, or likely to be, of importance to cultivators of cotton. It is made a condition of the grant that the University should admit cotton research scholars and assistants on study leave to its laboratories, and it is also asked to deal so far as it can with inquiries from scientific advisers to cotton growers. The work will be carried out in the Departments of Botany and Zoology under Mr. S. Williams and Mr. R. A. Wardle respectively. In this connexion the large and valuable collections of insects in the Manchester Museum will be of considerable assistance in the identification of insect pests, while the experimental grounds and greenhouses which the University has recently established in Fallowfield will greatly facilitate the study of plant diseases.

Sheffield.—The title of emeritus professor of mechanical engineering has been conferred on Dr. W. Ripper in recognition of the services he has rendered to the Department of Engineering and to the University.

Mr. Denton Guest has been appointed assistant bacteriologist.

Dr. K. Fassler of Freiburg (Switzerland) has been appointed, according to the *Chemiker Zeitung*, assistant and reader in mineralogy and geology at Laval University, Quebec.

The Educational Directory, 1922–23, published by the Bureau of Education, Washington, as Bulletin 1922, No. 50, contains not only the names of administrative officials—federal, state, county, town, university, college, and library—but also lists of boards, societies, and other organisations having educational aims, and a list of educational periodicals in the United States. The list of summer schools in connexion with universities, colleges, and normal schools is an astonishingly long one, containing more than 500 entries: in most cases the summer session lasts for from six to ten weeks.

The Clothworkers' Company of the City of London has offered an annual contribution of 3000*l*. for the period of five years 1923–1927 to the Imperial College of Science and Technology, South Kensington, to be applied towards the maintenance and development of the City and Guilds (Engineering) College, one of the three constituent colleges of the Imperial College of Science. This donation is supplemental to the sum voted some years ago by the Goldsmiths' Company, a gift amounting to 85,000*l*., which enabled the Engineering College to extend its premises, and is quite distinct from the annual vote of 5000*l*. from the City and Guilds of London Institute which has been paid to the Imperial College since the charter was granted some fifteen years ago and applied to the City and Guilds (Engineering) College. It is another indication of the value which practical men in the City of London attach to the research and general teaching in science specially in relation to industry.

In 1917 the Government, acting through the Board of Education and the Department of Scientific and Industrial Research in conjunction with the London County Council and the Governors of the Imperial College, South Kensington, established at the Imperial College, for a period of five years in the first instance, a Department of Optical Engineering and Applied Optics, in the charge of Prof. F. J. Cheshire. As the Department was originally sanctioned for five years only, the question of its future has recently come up for consideration, and it has been decided that it shall be put upon the same basis as regards permanency as the other Departments of the College. The work of this Department should do much to prevent a recurrence of the position in Great Britain in 1914, when optical manufacturers were severely hampered by the insufficient number of optical experts available both for the scientific direction of production and also for the designing and computing of new optical systems demanded by the Government.

In view of the jubilee celebration of the Cambridge University local lectures on July 6-9, special interest attaches to a review published in the May number of *School Life* (Washington, U.S.A.) of university extension work in America. The writer, who is president of the National University Extension Association formed in 1915, recalls that this work has been carried on in America since the inauguration of the Chautauqua gatherings in 1885, but it was not until 1906 that the University of Wisconsin, the pioneer State university in this field, organised its university extension division as an extramural college with a dean and separate faculty. Since 1913 the movement has spread so rapidly that now practically every institution of learning—university, college, normal, technical, or professional school, whether public or private, engages in some form of extension activity. The goal of the movement is thus described: "to fit every man and woman for his or her job, thereby making a better economic and social asset for the State." This insistence on the ideal of service to the State is characteristic of American writers on this subject and on elementary and secondary education. The National Association aims at standardising the character and content of courses, conditions of admission, etc. Among important recent developments of extension work in America are: co-operation with agencies such as state medical and dental societies and boards of health, extension courses for medical practitioners, and the utilisation of broadcasting stations. Nearly every state has now a correspondence school system supported by taxation, usually organised as a department of the state university.

Societies and Academies.

CAMBRIDGE.

Philosophical Society, July 16.—Mr. C. T. Heycock, president, in the chair.—W. M. H. **Greaves**: The possible mechanics of the hydrogen atom.—S. **Chapman**: The motion of a neutral ionised stream in the earth's magnetic field.—J. D. **Bernal**: Analytical theory of crystals.—H. F. **Baker**: Two geometrical notes: (1) Theory of confocal quadrics and Poncelet's porism of inscribed triangles. (2) A self reciprocal figure, and the associated cubic surfaces.—L. **Godeaux**: Sur la representation analytique des congruences de coniques.—C. T. **Preece**: Dougall's theorem on hypergeometric functions.—W. L. **Marr**: A quintic locus defined by five points in a plane.—J. **Brill**: On the problem of three bodies.—C. G. F. **James**: Extensions of a theorem of Segre's, with their natural position in space of seven dimensions.—T. M. **Cherry**: The form of the solution of the equations of dynamics.—R. A. **Fisher**: Note on Dr. Burnside's recent paper on errors of observation.—C. G. **Darwin** and R. H. **Fowler**: Further examples of partition functions.—H. W. **Richmond**: Real twisted cubics which are geodesics on quadric surfaces.

DUBLIN.

Royal Irish Academy, June 25.—Prof. Sydney Young, president, in the chair.—A. C. **O'Sullivan**: Corresponding points on the curve of intersection of two quadrics. Corresponding points on the curve of intersection of two quadrics u, v are defined as pairs of points the tangents at which to the curve are generators of the same species of the same quadric $\lambda u - v$. There are three kinds of correspondence, each related to one of the three ways in which the roots of the discriminant of $\lambda u - v$ may be grouped. If four points lie in a plane they, with their correspondents of the three kinds, lie in fours on 64 planes, 16 planes passing through each point. There exists a correspondence between the lines joining corresponding points and the points of the quartic curve, so that from any proposition relating to the points a proposition relating to the lines can be deduced. This transformation is expressed in elliptic functions by a quadric transformation which is equivalent to one of the forms of Landen's transformation, thus giving a geometrical interpretation in three dimensions of Landen's transformation for real arguments.

PARIS.

Academy of Sciences, July 9.—M. Albin Haller in the chair.—Gabriel **Bertrand** and Mlle. S. **Benoist**: The nature of "celloisobiose." The celloisoboise of Ost and Prosiegel and of Ost and Knoth appears from its properties to be a mixture of procellose, described by the authors in a previous communication, and cellose.—André **Blondel**: The conditions of yield of generating valve lamps having a characteristic of the singing electric arc: the definition of their power.—V. **Grignard** and R. **Escourrou**: The tertiary methylheptenols: their catalytic hydrogenation. The product of hydrogenation varies with the catalyst (platinum black, nickel), and also with the pressure of the hydrogen. The best results were obtained with nickel working under a pressure of about 15 mm. of mercury.—Serge **Bernstein**: The best approximation of functions possessing one essential singular point.—Nikola **Obrechkoff**: A problem of Laguerre. F. **Selety**: A distribution of masses with a mean density zero, without centre of gravity.—Th. De. **Donder**: The synthesis of the gravific.—André **Kling** and Arnold **Lassieur**: Aqueous solutions. A sketch of a theory explaining the behaviour of water towards indicators and the hydrogen cell independently of the ionic hypothesis.—Pierre **Bedos**: Ortho-phenyl-cyclo-hexanol and the bromhydrin of 1·2, cyclohexane diol. Ortho-phenyl-cyclo-hexanol is the main product of the reaction between the oxide of cyclohexane and phenylmagnesium bromide. It would appear to be a stereoisomer of the compound of the same composition obtained by Braun, Gruber and Kirschbaum by the addition of hydrogen to ortho-oxydiphenyl.—Pierre **Jolibois** and **Chassevent**: The setting of plaster. An account of experiments on the maximum solubility of anhydrous calcium sulphate as a function of the temperature to which it has been heated.—Victor **Lombard**: The permeability of nickel to hydrogen. If d expresses the volume of hydrogen passing through the nickel plate of area 1 sq. cm. then it was found that at constant difference of pressure on the two sides of the plate, $d = a^t$: at constant temperature, the yield of gas $d = K\sqrt{P}$, where P is the difference of pressure.—Roger G. **Boussu**: Contribution to the study of supersaturation. Details of experiments with supersaturated solutions of potassium bitartrate and calcium sulphate.—L. J. **Simon**: The oxidation of graphite by a mixture of silver bichromate and sulphuric acid.—H. **Gault** and G. **Ehrmann**: The soluble cellulose-ether salts of the higher fatty acids. Hydrocellulose is treated with an acid chloride and pyridine in the presence of a solvent. Descriptions of cellulose distearate, dipalmitate, and dilaurate are given.—Max and Michel **Polonovski**: Escrolmethene and its alcoholate.—F. **Delhaye**: Relations between the orogenic movements and the great depressions of Central Africa. The *graben* of Lufira (Katenga).—Mlle. J. Boisse **de Black**: The mode of formation of a *frane* in Cantal.—Allyre **Chassevant** and **Chouchak**: The measurement of the degree of ionisation of mineral waters.—H. **Ricôme**: Growth and heliotropism.—Jean **Politis**: The mitochondrial origin of the anthocyanic pigments in flowers and leaves.—M. **Piettre**: The humus in the coffee plantations in Brazil.—M. **Aron**: The influence of temperature on the action of the testicular hormone.—A. **Desgnez** and A. **Bierry**: The action of Vichy water on the urinary reaction.—Jean **Camus**, J. J. **Gournay**, and A. **Le Grand**: Experimental diabetes.—M. **Lévy-Solal** and A. **Tzanck**: Puerperal eclampsia and the phenomenon of shock. Arrest by pilocarpine.—M. **Bazin**: Animal and human neoplasms.

Official Publications Received.

Zoologische Mededeelingen, uitgegeven vanwege 's Rijks Museum van Natuurlijke Historie te Leiden. Onder Redactie van Prof. Dr. E. D. Van Oort. Deel 7, Aflevering 3-4. Pp. 129-252. (Leiden: E. J. Brill.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 6: Home Economics Education. By Henrietta W. Calvin. Pp. 19. 5 cents. Bulletin, 1923, No. 15: The Bible in the Public Schools; Legal Status and Current Practice. By William R. Hood. Pp. 13. 5 cents. Bulletin, 1923, No. 16: Statistical Survey of Education, 1919-20. By Florence DuBois. Pp. 41. 10 cents. Bulletin, 1923, No. 22: Educational Work of the Knights of Columbus. By Mark J. Sweany. Pp. iii+12. 5 cents. Bulletin, 1923, No. 25: Recent Developments in Educational Journalism. By Prof. W. Carson Ryan, Jr. Pp. 14. 5 cents. (Washington: Government Printing Office.)

The North of Scotland College of Agriculture. Guide to Experiments at Craibstone, 1923. Pp. 45. (Aberdeen.)

Department of the Interior: United States Geological Survey. Bulletin 732: Geology and Ore Deposits of Shoshone County, Idaho. By Joseph B. Umpleby and E. L. Jones, Jr. Pp. v+156+16 plates. 40 cents. Bulletin 740: Mica Deposits of the United States. By Douglas B. Sterrett. Pp. xl+342+29 plates. 50 cents. Bulletin 741: The Jarbridge Mining District, Nevada; with a Note on the Charleston District. By Frank C. Schrader. Pp. v+86+20 plates. 20 cents. Bulletin 743: Geology of the Oatman Gold District, Arizona; a Preliminary Report. By F. L. Ransome. Pp. iv+58+12 plates. 10 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 488: The Floods in Central Texas in September 1921. By C. E. Ellsworth. Pp. iv+56+8 plates. 15 cents. Water-Supply Paper 493: Hydroelectric Power Systems of California and their Extensions into Oregon and Nevada. Prepared in co-operation with the United States Forest Service. By Frederick Hall Fowler. Pp. xlix+1276+73 plates. 2.25 dollars. (Washington: Government Printing Office.)

Supplement to NATURE

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The Ether and Electrons.[1]

By Sir OLIVER LODGE, F.R.S.

PRELIMINARY.

I HAVE been asked to speak on possibilities of research in pure physics, and I rejoice that attention has always been paid to the vital importance of pure science in an Institution the backbone of the work of which must be of a metrical character connected with industrial applications, and much of it necessarily subject to routine.

The main lines on which physics has recently and is still so rapidly advancing are well known. There is no need to direct attention to such inquiries as are the direct outcome of radioactivity, in its various forms spontaneous and induced: problems which range from atomic investigations like those which go on in the Cavendish Laboratory, through X-ray and ordinary spectrum analysis, down to the various devices of wireless telegraphy. In all these things there are among the members of the staff of the National Physical Laboratory, and on the Governing Body, more than competent advisers.

I must just deal with such ideas as have been occupying my attention of late. I have found it interesting recently to look up some forgotten remarks of my own—made soon after a National Physical Laboratory was decided on, but before it was founded—in the preliminary portion of a presidential address to the Physical Society of London on February 10, 1899, as reported in the Proceedings of that Society, vol. xvi. Part VI., June 1899. Among other things there referred to, is a suggestion by FitzGerald that circularly polarised light sent through an absorbing medium might constitute it a magnet—a discovery not yet made. I see there also a reference to a Blue-book of 1898 recording a Government conference about the founding of this Laboratory. Sir Richard Glazebrook has also kindly directed your attention to my address to Section A of the British Association at Cardiff in 1891, in which the foundation of a National Physical Laboratory was specially advocated.

[1] From an address on "Some Possibilities for Research in Pure Physics, especially on the Ether," delivered to the staff of the National Physical Laboratory on March 14. The first section of the lecture is omitted for lack of space. It dealt with possible research in boundary or overlapping regions of specific sciences, and on the relation between physics on one hand, and chemistry, physiology, and biology on the other. This section, and one giving further details about the possibility of a renewed attempt to detect or to disprove an ether flow along lines of magnetic force, will be published elsewhere.

PROPERTIES OF THE ETHER.

The question of what constitutes a distinction between physics and chemistry is difficult to decide, but in general it may be said that chemists deal chiefly with static relations and groupings, while physicists are more inclined to treat phenomena kinetically. Another clear distinction, at any rate at present, between these two sciences is that one deals with matter only, and the other deals with the ether also. It seems that the electric charge is the unifying or connecting entity between matter and ether. Uncharged matter appears to have no effect on ether at all. But its charged particles, or electrons, in so far as they quiver or rotate, do disturb the ether and generate waves in it. Moreover, if they revolve or travel, as by locomotion, they generate magnetism in it; and even when they are stationary, they generate in it or rather are inevitably accompanied by what is called electric force. That is, they appear to attract or repel each other from a distance. Furthermore, for some reason—which I and some others think to be residual electric or possibly magnetic attraction,—they exert over minute ranges the force known as cohesion, which again must be exerted entirely through the ether, since particles of cohering matter are not in contact. And again they exert, even at the most enormous distances known to astronomy, the minute residual force known as gravitation; which in the case of bodies of astronomical size amounts to a force of gigantic magnitude.

Light, magnetism, cohesion, gravitation,—all these are affairs of the ether, and are all studied in physics. A superstition has recently arisen that the ether is an exploded heresy, and is unnecessary; but that is an absurd misunderstanding. The theory of relativity says nothing of the kind. As a mathematical method it need not mention the ether, any more than Laplace in his "System of the World" felt that he need mention the Creator. He was entirely within his rights in ignoring the Deity; and so is a relativist in ignoring the ether; at least when neither attempts to philosophise on that basis. For ignoring a thing is not the same as putting it out of existence. Extinction is as impossible to us as Creation. We have to take things as we find them: and we find ourselves imbedded in ether and matter. So we had better make the best of it.

PRESENT KNOWLEDGE ABOUT ETHER.

How much do we know about the ether, and how much is it possible to ascertain? We do not know as much as we ought, but we know a few things; and we hope by further investigation to know more.

Unfortunately, the ether is a very perfect, elusive, highly-endowed substance, which makes no direct appeal to any of our sense organs. Accordingly, it is only investigated with some difficulty; and its properties are so different from those of matter that very elaborate and expensive arrangements have to be made in order to cope with it. Even when we have made those arrangements, it may decline to give an answer, and the result may be negative. Still, a truly negative result is something definite, and is better than nothing. But every positive result is of extreme value. Let us summarise the results we already know.

First of all, we know that the ether can transmit waves at a definite and finite speed of 300,000 kilometres a second. Next, that those waves are electromagnetic, with the electric and magnetic vectors at right angles to each other, and in the same phase. We also know that the superposition of related electric and magnetic vectors in the same phase results in propagation with the speed of light.

Then we know that light cannot be transmitted by conductors of electricity, which act like a solution of optical continuity. Furthermore, inside a transparent body light travels more slowly than in free space, showing that the ether is affected somehow by the neighbourhood of matter; the amount of this affection being sometimes called the refractive index, which is the measure of the retardation experienced by light, and sometimes, from another point of view, the dielectric coefficient.

We further know that if transparent matter is moved in the direction of the light inside it, a certain fraction of its velocity is added to the light—added of course algebraically. Thus demonstrating, not that matter has any power of conveying light—which it has not—but that some influence or reaction on the ether belongs to the matter and travels with it; that influence being just the one which effected the retardation and is responsible for the refractive index, the fraction of added velocity being, as surmised by Fresnel, $1 - 1/\mu^2$.

We also know, from certain experiments conducted by myself, that this property of matter does not extend in the slightest degree beyond its boundary; so that however fast matter is moving, light just outside it is not affected at all. Or, as we may express it, matter has no power of carrying the ether with it. The ether has nothing of the nature of viscosity. If a fluid at all, it is a perfect fluid. Not even if the matter is charged or magnetised does the influence extend beyond its boundary so as to affect the stream of light close to it. (See *Phil. Trans.* 1893 and 1897.)

Yet inside transparent matter the phenomena of light show that the ether must be modified in many ways, giving rise to all manner of crystalline effects —the optics of crystals—and the various phenomena of polarisation; especially that interesting one discovered by Faraday, that the plane of vibration is rotated, in one direction or another, by even non-crystalline and fluid matter when immersed in a longitudinal magnetic field: and those other phenomena discovered by Kerr, all of which may be summed up under the names elliptic and rotatory polarisation.

It is easy enough to say that light is retarded to a definite extent by transparent matter, but the complete theory of it is not so simple. Something about it will be found in the writings of Sir J. J. Thomson. All the phenomena of dispersion and anomalous dispersion must be taken into account if we would understand the inter-relation between matter and ether.

New Effects.

Not long ago the interesting phenomenon was discovered by Prof. Richardson that the act of magnetisation rotates a piece of iron, and a quantitative investigation of this delicate effect has been made recently by Prof. Chattock and Mr. Bates. I understand that a converse effect has now also been observed by Mr. Barnett, namely, that rotating a piece of iron magnetises it. I remember making an attempt to discover such a phenomenon long ago at University College, London; but I found nothing securely. Capricious and spurious effects were difficult to avoid, and I suppose I had not sufficient perseverance. We knew nothing in those days about electrons or their orbits, though we felt that there was something rotatory about magnetism; nor was it more than a suspicion that electricity itself might possess a trace of inertia, in addition to the recognised quasi-inertia of self-induction. Modern skill may have been able to overcome the difficulties inherent to such an experiment, but caution is desirable, since it is not clear why rotation should develop one polarity rather than another, if the atomic arrangement were truly random.

There is more to be got out of the original discovery by Richardson than has yet appeared—and I venture to predict that we have by no means heard the last of it. The Zeeman effect seemed small at one time; and if it be said that the Richardson effect could have been anticipated, I reply that Larmor anticipated the Zeeman effect; though it is true he did not expect the right magnitude, because the mass of the particle responsible for radiation was not then known. The quantitative relations of the Zeeman phenomenon clearly showed, for the first time, that the radiating particle was one of electronic and not of atomic mass.

I mention these two apparently disconnected phenomena together advisedly; for while the orientation or precession of electronic orbits in gases account for the Zeeman effect, the orientation of electronic orbits in iron accounts for the Richardson effect. Both are small, but the Zeeman effect is the smaller of the two; it needs the appliances of spectrum analysis for its detection. It is far bigger than it would have been if the atom had been the radiating element instead of the thousand-times smaller mass of the electron. As to the Richardson effect, it is surprising that it has been observed and measured at all, for the smallness (in mass) of the electron is no help to that; and the detected reaction is not something optical or etherial, but the gross movement of a mass of ordinary matter. Not much movement, truly,—quartz fibres must be used of course, and plenty of refinements,—but still a material movement is observed as the result of orientation of electronic orbits; and that is noteworthy. Reaction of radium from atomic projectiles was observed before, and reaction of radiometer vanes too; but alpha rays are atoms, and these

effects are connected with atomic bombardment; so in that respect they differ from the effects just mentioned.

I would liken the Richardson effect in some respects more to the Lebedew and Nicholls and Hull detection of the pressure of light, as suggesting an etherial reaction on ordinary matter.

Referring to this light-pressure; it is so small that Crookes failed to detect it, just as Faraday failed to detect the Zeeman effect with the appliances of his day and without a Rowland grating; but the most trivial fact, so it be a fact, is of enormous and may be of cosmic importance. Poynting invoked light-pressure to account for cometary and other astronomical results; and now Eddington calls upon it to sustain the Atlas-like burden of holding up the billions of tons of superincumbent material which constitutes the crust or envelope of a giant star. An amazing application of the (terrestrially) almost infinitely small.

Parenthetically, in using the term so-and-so's "effect," I do so under protest. This personal kind of nomenclature should be temporary, and not outlive the generation of discovery. This kind of naming began with either the Doppler or the Peltier effect, and was right enough when novel effects were few; but now that they constitute a multitude, we older folk are apt to get confused among the plentiful crop which the more fortunate youngsters are continually evolving. Prof. Richardson is entirely free from blame, for he calls his discovery a gyro-magnetic effect; which is explicit and satisfactory.

The Positive Electron.

Before leaving this part of the subject I should like just to direct attention to what I have written in Nature for November 25, 1922, p. 696, that we have not yet securely discovered the positive electron. The proton has to serve that function for the present, but what the constitution of the simplest known nucleus of an atom is, remains to be determined. Something is known about the proximate or apparent constituents of some heavier atomic nuclei, though not much, but nothing at all of the constituents of the nucleus of a hydrogen atom. It *may* be an indivisible particle so small and concentrated as to have a mass 1800 times that of a negative electron; but to me it seems unlikely that this is the right solution. It *may*, on the other hand, be built up of a stable grouping of hypothetical electrons both positive and negative,—each one being like a mirror image of the other. If so, it remains to be explained why the outstanding charge of all atomic nuclei is apparently positive, and whether that is accurately true. All I advocate is to keep the door open for further investigation, and to persevere with the quest of the positive electron by any methods that may suggest themselves.

Why negative electricity should differ from positive so greatly, or in any respect save in sign, is not at all clear; and it is difficult to understand how one of these entities can have been constructed out of the ether, without the simultaneous production of its opposite partner.

Electrical Theory of Matter.

The mechanics of the ether are not yet known; and until we have devised some system of mechanics which applies, not in a blindfold, but in a clear and lucid, manner to the behaviour of the ether, we must remain to some extent in the dark. Here, then, is scope for experiment. At present we are using ether waves to examine the properties of matter, the structure of crystals, the structure of molecules, and even the structure of the atom. But we must go on in due time to use these phenomena for an investigation of the ether itself. We know that movement of matter does not affect the refractive index nor the polarising properties of that matter. But we know that if matter is moving fast enough, it tends to carry some ether with it, and thereby adds to its own inertia to a known and predicted extent. We also know that inertia itself is a magnetic and therefore etherial phenomenon. The way in which J. J. Thomson, Heaviside, and Larmor have worked out the electrical relations between ether and matter, as regards inertia, changes of inertia with speed, and radiation consequent on acceleration, has been a marvellous achievement of our time, of which quite inadequate popular notice has been taken. Still there it is. They have laid the foundation of the Electrical Theory of Matter, and have opened up a way for our descendants to explain nearly all the properties of matter in terms of the ether, and possibly the very existence of matter itself.

We do not yet know how an electron is composed. We know still less—if that is possible—how a proton is composed. But that they ultimately will turn out to be etherial structures of some kind is possible and, as I think, probable.

Meanwhile we know that not only the mass of bodies, but their shape, is affected by motion through the ether; this was demonstrated by that great experiment of Michelson's, which I regard primarily as an experiment on matter by means of light, and not an experiment on light by means of matter. It may hereafter be regarded by a sensible though preposterous historian—that is, one who puts the cart before the horse—as the first and only verification of the Fitz-Gerald-Lorentz theory of modified electrical cohesion, or peculiar interaction between moving particles. It has been used as the foundation of the Theory of Relativity. But that is an ingenious offshoot or excrescence. I should like everybody to realise that the Electrical Theory of Matter had already accounted for nearly all the things which drop out so naturally from the theory of relativity: such as the increase in mass, the FitzGerald contraction as a reality, the Fizeau effect on light; even an extra revolution of the axes of a planetary orbit, unless gravitation itself is modified by motion. (See several Articles in the *Phil. Mag.* between August 1917 and June 1918, by Prof. Eddington, G. W. Walker, and myself; beginning with page 81 of vol. 34, and with conclusions summarised on pp. 143, 482, and 486 of vol. 35.) The Electrical Theory of Matter may conceivably be made to account for the two other as yet incompletely verified gravitational effects so brilliantly predicted by Einstein. But that remains to be seen.

Possible Experiments.

Limits of space will not permit me to deal here with the possibility of an experiment to determine whether there really is etherial circulation along magnetic

lines of force; attention may be directed, however, to papers describing my early attempts at such experiments, as partly described in the *Philosophical Magazine* for April 1907 and May 1919. In making experiments on the ether we must recognise that what we set out to look for we may not find: but we can also remember that careful and conscientious experiment, conducted with good apparatus, must lead us somewhere, and may result in a discovery exceeding in importance and interest any property we had set out to examine.

Kinetic Elasticity.

The contrast between the kinetic and the static mode of regarding things runs all through physics. Most physicists are imbued with the more fundamental character of a kinetic explanation, and never feel really satisfied with an explanation in terms of static or potential energy. Of the two kinds of energy, kinetic appears to them the more fundamental kind.

So, as we all know, Lord Kelvin tried to explain the elasticity of a spring balance, or any spiral spring, by means of gyrostats, or spinning tops. He was able to devise, at any rate theoretically, two concealed mechanisms, one of which was static and the other kinetic; that is to say, one of which contained a spiral spring with a protruding hook at the end, while the other contained a precessing system of gyrostats, also with a protruding hook. The observer was challenged to hang things on the hook, or to feel its recoil, and to say which was which. Or, in more general terms, Lord Kelvin endeavoured to devise a kinetic theory of elasticity. His famous theory of the vortex atom, in which he tried to explain some of the properties of atoms in terms of vortex rings and their collisions and interactions, was of this nature. It was extended by J. J. Thomson at an early date into almost chemical regions, in his early Adams' prize essay.

In his later life, Lord Kelvin was inclined to abandon this view of elasticity as regards solids; and his vortex atom declined to satisfy either him or others, on further development. But none of these ideas should be completely abandoned. In so far as they successfully illustrated any of the properties of matter, they are worthy of consideration. Although we now know that the atom is not a vortex ring, or anything like it, I would challenge any one to say the same of an electron. The electron has become the fundamental material unit: and what its constitution may be, we none of us know. It must be in close relation with the ether, and must ultimately, as I think, be explicable in terms of the ether. But the fundamental properties of the ether are too little known at present to enable this to be done. We cannot say whether the electron is to be explained statically as a knot or other geometrical configuration or strain centre, on one hand, or as some kind of circulating or vortex movement on the other. The constitution of the electron remains for discovery, in spite of all the work of Larmor on the subject in his brilliant book "Ether and Matter," and other papers imbedded in the *Phil. Trans.* If it should turn out that an electron can be thought of as a knot or any kind of static strain, then I for one feel that that cannot be regarded as an ultimate explanation, though a most useful approximate one, and that the strain will have to be resolved into or accounted for by some kind of etherial vortex motion.

Not only have the electric and magnetic forces belonging to an electron, respectively at rest and in motion, to be explained; but also the slight residual strain depending on the square of the charge, and therefore irrespective of sign, which we call gravitation, has in a complete theory to be explained also. For few can doubt, I think, that gravitation must now be regarded as a function of the electron and the proton, that it is not something which springs into being when these units are associated so as to constitute an atom of matter; it is unlikely that the tight packing of a large number of hypothetical positive and negative units in the proton could account for it. More likely gravitation will turn out to be an etherial phenomenon explicable in terms of the beknottedness which distinguishes the singular point of an electron from the rest of the ether. The rest of the ether is not affected by gravity, but possesses qualities akin to what in mechanics we call elasticity and inertia. Otherwise the unspecialised ether of space could not transmit radiation, or sustain a magnetic field—as we know it does. For it is necessary always to remember that though electric lines of force terminate on material units, most of their course lies in undisturbed ether: while magnetic lines of force do not terminate at all, but are always closed curves, surrounding electrons in motion, but themselves existing, I presume, wholly in the ether, and showing every sign of being essentially a kinetic phenomenon, demonstrative of inertia.

Inertia itself I see no way of explaining in any fundamental manner. It seems to be a property that we must postulate as existing in the ether,—a property akin to density; though it is true we can explain the inertia of matter—that is, of any material unit—in terms of the concealed magnetic fields inevitably associated with its motion.

To leave these more transcendental regions for the present, we may recall that although the kinetic theory of elasticity has hitherto failed to develop in connexion with solids, it holds perfectly for the case of gases. The elasticity or recoil of compressed air used to be thought of as analogous to the recoil of an elastic spring. But Waterston first, and then Joule and others—including especially Maxwell and Clausius and Loschmidt,—explained it brilliantly, together with many other of the metrical properties of gases, as the result of molecular motions and bombardment; so that it has become a familiar and elaborate theory —the Kinetic Theory of Gases. Hence, in that form of matter about which we know most, the kinetic theory of elasticity holds the field.

Radiation and Matter.

Now come a series of questions which it is difficult to formulate precisely because of our inadequate knowledge, and concerning which we must make the best of the hints which from time to time are afforded us by Nature,—questions which are mainly concerned with the nature of radiation, and with the interactions between ether waves and ordinary matter.

It is unnecessary to point out in the first instance that light is now known to exert pressure, and therefore to convey momentum. An advancing wave-front possesses momentum, which it can transmit to any obstacle which either reflects or absorbs it. If reflected, the pressure it exerts is double what it exerts when absorbed; all quite in accordance with common sense. But I rather want to concentrate attention on the state of things when the wave-front is advancing—it may be for hundreds of years—through so-called empty space. It carries with it a pressure equal to the energy per unit volume. If the Third Law of Motion is true without exception,—and it is surely politic to assume the truth of that law until it is negatived,—there must be a longitudinal stress in that stream of light, with a reaction on the source at one end and on the advancing wave-front on the other.

The source is always something material. Light can only emanate from an accelerated—that is, from a revolving or vibrating—electron. Hence, at that end the reaction has a material basis, in accordance with the customary experience that a line of stress must stretch from one piece of matter to another. But what happens at the other end? When it encounters matter, the reaction is exerted on that matter, and everything is plain sailing. But while it is advancing in free ether, what is it that sustains the reaction? We can only answer, the wave-front. The wave-front cannot sustain it statically. It can only do so by advancing at the speed of light. But it is remarkable and worthy of note that in this particular the advancing wave-front simulates one of the properties of matter, namely, the power of sustaining stress.

Now to me this is very suggestive. We do not know what precisely is the kind of motion occurring in the associated electric and magnetic vectors which are travelling with the speed of light. We do not know the kind of motion associated, more statically, with an electron. But the guess is almost forced upon us that possibly these two kinds of motion are not entirely distinct. We could not say that perhaps they are one, and not two; for there are certainly differences between them. One must advance; the other may stay still. But is it possible to regard one as a consequence, or as a generator, of the other?

The electron generates light.

Does light generate an electron?

(I am using the term "Light" in a very general sense, not limiting it to the physiological kind which excites the sense of vision, but including X-rays, and all other forms of short wave radiation.)

What do we know about the effect of this kind of radiation upon matter? We know that it can produce the irregular movements that we call heat, and also that it can stimulate chemical action. But the discovery of photoelectricity shows us that it may do more. It may fling out an electron, with a surprising amount of energy, dependent upon the frequency, that is, upon the wave-length, of the incident radiation. This is a hint not to be ignored. Nor is it ignored; and there must have been many speculations as to the kind of way in which it achieves this result. One would naturally suppose at first that it must do it by means of resonance, that is, by the accumulation of properly timed impulses, until an explosion occurs. But the evidence is, on the whole, rather against a resonance view; because the result seems almost independent of the intensity of the incident radiation, and to depend only on its wave-length. Nor does it seem as if a great length of radiation was necessary in order to produce the result: though this is a matter which requires further and more conclusive experiment. If a beam of light is interrupted and cut up into small sections—as might be done by a narrow slit in a very rapidly revolving disc,—would this intermittent light be equally effective? For if it is equally effective, the fact would tend against the continuous accumulation of a small synchronous disturbance.

I believe that some experiments have been made in this direction, and that the answer—so far as it goes—is that intermittent is as effective as continuous illumination, and feeble light as efficient as strong. The energy falling upon a minute surface in a beam of diffuse light is insufficient to account for the energy of the resulting effect, unless it is a trigger effect.

But this rather wants pressing to extremes. To cut up a beam of light into really short portions is not very easy. If a radial slit a millimetre in width is made in a disc a metre in diameter, revolving a hundred times a second, light sent through it is diluted and cut up into sections; but the length of each section is still about a mile, and accordingly would contain more than a thousand million waves,—which is amply sufficient for resonance.

However, the evidence so far is supposed to negative the resonance idea: so much so that it has been supposed that the wave-front is not a uniform surface, but a speckled one; that it is discontinuous; and that the amount of energy concentrated in one of the specks may be vastly greater than would be reckoned on the diffuse or continuous theory.

The idea of a speckled wave-front would have seemed to our scientific ancestors rather wild; though it must be remembered that Newton, with his Corpuscular Theory, was temporarily satisfied with something very like it. Nevertheless, the Corpuscular Theory had to be abandoned because of the artificial way in which it explained polarisation, and because it seemed to require that light should travel quicker inside matter than outside, instead of slower—as Foucault proved it to do,—and because there are real difficulties in explaining interference and diffraction, unless the wave-front is continuous.

However, it does not do to turn down a theory too readily and prematurely, merely because we encounter a few difficulties. No hypothesis is wild which has attracted the serious attention of J. J. Thomson, and other brilliant physicists, including—as I think we must—even Faraday; as evidenced by his "Thoughts on Ray Vibrations" ("Experimental Researches," vol. iii. p. 447).

Moreover, though these ideas, as we perceive them at present, may not be able to substantiate themselves, yet they are the outcome of observed facts; and it may yet be found that, in a modified and revolutionised form, they may contain elements of truth at present unsuspected.

Wilberforce Model.

It may be said that if we depend on the pressure of light as conveying energy, it is a longitudinal phenomenon; whereas an electron is probably a rotatory or rotational phenomenon. Or again, if we attend to the magnetic oscillation in the beam of light, and consider that the electric oscillation is separated from it, or neutralised, by matter, that still there is nothing of the rotational kind about it.

One answer would be that circularly polarised light clearly has a rotational aspect. Another and more fundamental answer would direct attention to the transition, or interchange, that may go on between a linear oscillator and a rotational oscillator when they are of the same frequency, or properly attuned.

In illustration of that, I would invite attention to the illustrative models constructed by Prof. Wilberforce, my successor in the chair of physics at Liverpool, which show that a continual interchange of energy between a linear vibration in one direction, and a rotational vibration in a plane at right angles, naturally goes on when the two modes are synchronous. Thus the energy alternately takes first one form and then the other; and then back again, without intermission.

Of course the dynamics of the model is thoroughly understood, and Wilberforce himself has explained it, that is, has recorded the relevant equations;[2] and in that sense there is nothing puzzling about it, though its behaviour can be made to look rather paradoxical. But I feel that there is some meaning underlying the possibilities here indicated, which are not yet completely exhausted, and that they may, when more deeply considered, throw some light upon the interaction between electricity and magnetism—if that should still be necessary,—and possibly on the interaction between ether and matter, and perhaps between waves and electrons, where more information is certainly necessary. At any rate, I regard the behaviour of the model as suggestive, and am content for the present to direct attention to it, from this point of view.

Origin of Electrons.

Let us assume, then, for a moment that there may be some truth in the idea of a discontinuous wave-front. To what are we led? I should reply, that the motion in a wave-front seems more akin to the kind of motion that constitutes the discontinuous and isolated speck that we call an electron; and that the actual generation of an electron by means of light is not an altogether impossible idea.

So I repeat the question:

An electron suddenly set in motion generates light: does light when it is suddenly stopped generate an electron?

Sir William Bragg has often directed attention to the singular relation existing between X-rays and beta radiation. The impact of a beta particle emits X-rays. The impact of X-rays emits a beta particle. The energy of the original and the excited beta particle are so closely proportional as to be practically identical. It is as if the same beta particle, that is, the same electron, had gone out of existence at one place, and been recreated at another, the intermediate link being constituted by specific radiation of a perfectly definite wave-length.

There is no need to *assert* that one particle has gone out of existence and the other come in; and yet we know of no reason for denying it. It may have to be denied, but I think it wise to keep an open mind on the subject, however bizarre the notion may be. There are strange relations between energy and matter now coming to the front. Matter contains intrinsic energy, as if it were something circulating with the velocity of light. There must be some meaning in this. The ratio c^2 between matter and energy is not to be ignored.

Somehow or other the ether possesses inertia. It must, or it could not sustain magnetism, or account for the increase of inertia due to motion. The ether also contains an intrinsic and characteristic velocity, which is perfectly definite. It is known that the vibrations of vortices, and the speed at which a vortex medium can transmit transverse waves, are closely connected with the constitutional velocity of rotation. The two velocities are in fact equal, or connected by a numerical factor, of a magnitude which some theories make $\sqrt{2}$, but other theories make unity. In any case the numerical factor is not far from unity. We are justified in supposing that if the ether is full of circulatory motion, that motion must be practically the velocity of light. In that case, the fundamental nature of matter would appear to be giving up its secret; and the relation between matter and energy would be explained.

There does not then seem any insuperable difficulty about hoping that some future discovery will be able to generate matter, or at least to generate an electron, by aid of X-rays or other form of radiation. I can dimly conceive a theory of light which, when its advance was stopped, should terminate not in the irregular jostle called heat, but in the regular circulation or vortex motion that we call an electron. The intimate relation between energy and frequency associated with the quantum seems to me to negative the mere irregularity of thermal agitation, and to suggest something quite regular and constitutional.

We can go further, and can reckon how much matter would be generated by a given amount of luminous energy, if none of it were wasted as heat. A beam of ordinary sunlight ten centimetres square shining continuously, and supposed to be all converted or interpreted as matter, would generate a weighable amount, namely one-tenth of a milligram, in seventeen years.

The density of sunlight near the earth is equivalent to 2×10^{-15} gram per second per square centimetre. So if it were interpreted as matter, the earth would catch 80,000 tons of it per annum. Of course, some of it is wasted. Only radiation of the right frequency is effective, just as only energy of the right frequency is generated by a metrical impact. A lot of the radiation may be due to irregular jostling, and this portion when absorbed may result in heat. But it is the more precise kinds of occurrence which are instructive, and which must inevitably attract attention.

I know that the Bohr Theory of the Atom seems at first against these speculations. Electrons appear

[2] *Phil. Mag.*, October 1894.

to jump from one orbit to another, and thereby give out a certain quantum of energy. But this may be a supplementary and not a contradictory statement. What makes the electrons jump? Which electron jumps out? Sometimes it is from the K ring, sometimes from the L ring; and so on. All those things may be known. But still I ask, What started the disturbance? If an electron is generated by the impact of light, it does not follow that that particular electron is the one ejected. Its entry may be the means of ejecting another. Somehow or other the atom must get another, in order to restore its constitution. There are doubtless many ways in which a strayed electron could be recaptured; and I venture to suggest that our speculation suggests one of them.

Possible Utilisation of Waste Radiation.

There is an immense amount of radiation travelling about space. The whole amount of solar radiation is portentous. The fraction which the earth catches, though terrestrially so important, is but a minute fraction of the whole—less than the two thousand millionth part,—and it seems to have been going on for hundreds of millions of years. The radiation from many of the stars is greater. What becomes of all that radiation? Is it all waste? Space is so enormous that though thousands of millions of suns have been pouring out their energy for thousands of millions of years, space is no warmer. The ether is not warmed by it: the ether does not absorb it. The ether is perfectly transparent. Yet our instinct rebels against the idea that all this radiation results in nothing. Sir W. Siemens speculated as to its possible concentration by total reflection at an ether boundary. But I cannot imagine an ether boundary. I can more readily imagine that light results somehow in the generation of matter; and that there is a reciprocal interaction between matter and ether waves; so that each is generated by the other,—a sort of constant and perennial interchange.

Electrons have come into existence somehow. The subject of origins usually lies outside science. The origin of matter is as beyond our ken as the origin of life; and yet people speculate about the origin of life. Some highly estimated men of science *hope* at any rate that some day the chemistry and physics of life may be so far understood that a highly complex assemblage of organic molecules may simulate and perhaps adopt its functions. I see nothing inconceivable in this. Life has originated somehow; and if we can get to understand anything about its origin, the effort is legitimate. It may fail; but it would be a very superficial view of religion which resented its success. Mind dominates matter; and the mind of man is not altogether of a different order from the mind of the Creator. But this is a subject on which I could say more on a more suitable occasion. I only say thus much now in order to repel any idea of impiety in speculating on a possible origin for matter.

Hypothetical Conversion of Radiation.

The possibility that a small body may gradually grow in mass under the influence of an etherial transformation, does not seem one to be scouted without proper examination. The amount of matter scattered about in space is by no means inconsiderable, and the problem of its origin has never been attacked. Given matter, the origin of radiation has been more or less solved. But, given radiation, the idea of its conversion into matter has not, so far as I know, been mooted. Possibly the idea is erroneous. But interactions in Nature are so frequent, and the interrelations between ether and matter are so ill understood, that I think we should not shut our eyes to the possibilities of some reciprocal interaction, even of a generative kind.[3]

Sometimes I see the difficulties of the hypothesis; sometimes I feel impressed with a sort of probability about it. It is easier to see the difficulties than the probabilities. But the relationship between energy and matter—connected as they appear to be with the second power of the characteristic ether velocity, and with the conception of an intimate fine-grained rotational structure for the ether—is not a hint that should be too lightly ignored or neglected.

Electrons build up matter. What builds up electrons? They are somehow intimately connected with the ether; their motion through it displays to us the phenomenon of magnetism; and their acceleration generates waves. So far, we are on firm ground. When we come to the converse or reciprocal relations, we have but few facts to stand on. But the emission of electrons by means of light is one of them; and the bearing of this fact, until it is properly understood inevitably justifies speculation.

Previous Guesses.

When I say that the idea of reciprocal conversion has not been mooted, I am going beyond the facts. In Loring's "Atomic Theories," page 80, I find the following sentences:

"Thus it would seem that the energy phenomena are reversible, so that the radiation is as it were convertible into moving electrons and moving electrons are convertible into radiation. It is of course only the energy which is thus convertible. The mechanism of conversion is not, however, known."

Again, in Millikan's book "The Electron," when speaking of Barkla's discovery of the remarkable absorbing property of matter for X-rays, he says:

"It will be seen from these photographs that the atoms of each particular substance transmit the general X-radiation up to a certain critical frequency, and then absorb all radiations of higher frequency than this critical value. The extraordinary significance of this discovery lies in the fact that it indicates that there is a type of absorption which is not due either to resonance or to free electrons. But these are the only types of absorption which are recognised in the structure of modern optics. We have as yet no way of conceiving this new type of absorption in terms of a mechanical model."

Sir William Bragg, in Nature (1921), vol. 107, p. 79, with reference to the experiments of Duane and Hunt, says: "Exactly how this strange transfer of energy from one form to another takes place we do not know: the question is full of puzzles." He has several times urged the extraordinary character of the fact that a stream of radiation excited by the

[3] Cf. letter in Nature, May 26, 1923, p. 702.

impact of one electron, after travelling a long way and becoming greatly enfeebled, can eject another electron with the same or nearly the same energy as the first. Facts such as these have suggested the discontinuous nature of a wave-front, and the actual concrete existence of discrete tubes of force, which are apparently analogous to, or suggestive of, vortex filaments in the ether. Again, there is the fact that the electrostatic potential energy of a charge is similar to what the equivalent mass would possess if it were moving with the speed of light. Also, *à propos* of this, I understand that Sir J. J. Thomson has expressed himself thus:

"When the energy of a system passes from kinetic into potential, there need be no transformation of fundamental energy, but merely the flow of a mass-producing material, with its intrinsic kinetic energy, from one position of space to another, under the guidance of the lines of electric force."

In accordance with a few other physicists, Thomson has been led to postulate a fine-grained structure for the ether, which I think rotational, but which he speaks of as particles. He suggests that mass is made up of identical particles all of the same kind, very small compared even with an electron, moving with the velocity of light, and subject only to a deflecting acceleration, not to any change of energy; the mass and energy of each particle being constant, but their distribution depending on the number or concentration of lines of force, each line being as it were anchored normally to positive and negative electrons, but capable of being thrown by motion into loops or closed curves, which would then move away with the velocity of light and constitute radiation. Wherefore it would follow that emission of radiant energy must be accompanied by a diminution in the mass of the radiating body.

The converse, therefore, that absorption of radiant energy might be accompanied by an increase in mass, almost naturally follows.

My presidential address to the Physical Society of London on the subject of opacity, that is, on the orthodox theory of absorption generally,—electrical as well as optical,—is contained in the *Phil. Mag.* for April 1899, and also in the Society's Proceedings; in the latter place it is preceded by preliminary matter not irrelevant to the present discussion.

Mechanism of Absorption and Emission.

To understand the mechanics of absorption we can learn from the mechanics of emission. In a wave the electric and magnetic vectors are simultaneous; that is, the electric and magnetic displacements exist together, superposed. At a source they are only coexistent in space, not in time; one succeeds and gives rise to the other, with successive alternations. A source may be at rest, and is merely an alternator: a wave is necessarily in motion. The relative phases of electric and magnetic oscillations in the neighbourhood of a source determine the fact and the direction of motion at each locality. Combined in one phase they expand or advance, combined in another phase they contract or recede; all this is known to occur near the source, that is, near a Hertz vibrator. In that region, within a radius of $\lambda/2\sqrt{\pi}$, the etherial disturbance oscillates to and fro; and beyond that range a portion of the energy acquires its locomotive character, and sets out with the velocity of light.

Shall not the converse take place when this speed of propagation is annihilated, and the ether disturbance is reduced to locomotive rest, within a similar range near an absorber? In that region the simultaneous electric and magnetic disturbances would be separated, and converted into a stationary oscillation, by a process inverse to that of radiative emission.

Considerations of this character are indicated by me more quantitatively in the *Phil. Mag.* for June 1913, pp. 770-788, and in February 1920, p. 173; also in April 1921, pp. 555-557, where I endeavour to associate the ultimate fate of radiation with a kind of Einsteinian gravitational theory. It there turns out to be necessary to examine electrically the essential nature of absorption; and the illustration or analogy with a Hertz vibrator, as either source or sink, is employed. I return to the subject in June 1921, p. 943, and again in July 1921, pp. 181-183; though in the last paper the chief point is the disintegration of atoms which is to be expected at a certain calculated very high temperature—such as has since been considered by Prof. Eddington likely to occur in the interior of giant stars.

Eddington has taught us—at any rate hypothetically—that in the interior of giant stars, where the temperature is excessive and the radiation powerful beyond easy imagination, the substance of the star is distended, blown out, supported, as it were, by radiation bombardment, as the skin of a football, or an india-rubber tyre, is distended by the molecular bombardment of the air inside. He has further speculated, so I understand, that the interior of these stars may constitute a laboratory in which the more complex atoms can be built up,—those same heavy atoms of which we have now at length begun to witness the breaking down, under the operations of spontaneous radio-activity. There cannot be breaking down everywhere: there must be building up somewhere. We do not yet know what can be accomplished under conditions of extreme heat and pressure,—nor, I may add, under conditions of great pressure combined with extreme cold.

It may be said: the analogy fails, since what I am trying to suggest is the generation of electrons, and we nowhere know of the breaking down of electrons. That is true: we do not know either of their breaking down or their building up. It may be that we shall discover the untying of an electron first; or it may be that we shall discover a tying-up first, and the untying later. Or it may be that, once tied, they are permanent. Or of course it may be that they cannot be tied. But these questions seem to me all open. The time for discovery is not yet; but he would be rash who would say that discovery in any particular region is impossible. If there are any clues, it is the privilege and indeed the duty of science to follow them up. If the clues are imaginary and useless, then open discussion will demonstrate their futility. But if we can see any distance, however dimly, into the unknown, then sooner or later we may be sure that pioneers will explore those dim regions until they are illuminated with the searchlights of systematic knowledge.

SATURDAY, AUGUST 11, 1923.

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Pensionable Teaching Service.

IN our issue of November 18, 1922, we published a leading article dealing with the principles of Circular 1286 issued by the Board of Education. That circular attempted to define what was a "Full-Time" Teacher within the meaning of the Superannuation (Teachers) Act of 1918, and the attempt was by no means successful in so far as it applied to teachers of experimental science and teachers of technology generally, and particularly to teachers of advanced subjects in Technical Institutions. In the article referred to we pointed out the salient defects of the proposals, and we are pleased to record that in Circular 1311 of the Board of Education now before us there are not only some modifications but also some "explanations" which in themselves modify the original proposals considerably and suggest that Full-Time Teaching Service will be determined on broader and more knowledgeable principles than were indicated in Circular 1286.

In the new circular—we wonder, by the way, why it was not issued as a "supplement to Circular 1286"—the Board of Education states that it will apply the principles set out in the original circular, subject to the modifications and explanations indicated. These modifications go far to meet the objections raised in our article referring to Circular 1286.

The Board makes it clear that the 30 hours suggested as a weekly minimum (for 36 weeks, or the equivalent) were intended to include not only the hours of actual teaching but also hours devoted to subsidiary duties entailed by actual teaching; that actual teaching covers not only class teaching in accordance with a regular time-table, but also the supervision of preparation and tutorial work with individual pupils or small groups of pupils; and that the subsidiary duties to be taken into account are not limited to those which are performed on the school premises, since in many cases some of them can be performed more conveniently—and, we may add, more efficiently—elsewhere. Those explanations should help to round off many sharp edges of the parent circular.

There is also a more definite statement in respect of relief from actual teaching hours for heads of departments in Technical Schools and for assistant teachers in secondary and other schools who are charged with substantial duties in organising particular subjects or in organising features in the corporate life of the school. This is only right, and we are glad to see it definitely pronounced.

In clause 7 of the original circular there was a reference to research work which we considered to be very unsatisfactory. The Board now states that time spent

in instructing students in the methods of research will be regarded as forming a part of the teaching. Further, it is stated that research work which enters into the actual preparation of lessons to advanced students will be properly regarded as a duty subsidiary to actual teaching.

On the whole, then, it may be said that the new circular is more reasonable and more justly favourable than the old. We still feel that teachers in Technical Institutions may be penalised if their full-time service is to be judged by the same standard of actual teaching hours as that which normally obtains in Primary and Secondary Schools. We admit that the circulars do not say they will be so judged, but, on the other hand, there is no statement, direct or implied, that the same standards exactly will not be applied. That would be extremely unfair, and extremely bad educationally, to those teaching subjects which involve experimental demonstration and laboratory preparation, and to those teaching advanced subjects. A definite statement on this point would have allayed anxiety on the part of many who are approaching the pensionable age.

Further, most of the work done by full-time teachers in Technical Institutions is evening work, and this work is necessarily more intensive, and involves not only a heavier strain in the actual teaching process but also much more complete preparation work than is required for corresponding day work. We regret that this has not been recognised in the new circular, for even though the officers of the Board may recognise it and act upon it, it does not seem fair either to the teachers concerned, or yet to the Principals and Education Authorities, that no definite pronouncement is made on the subject.

Finally, we cannot help feeling that Circular 1286 should not have been issued officially before it had been submitted to representatives of the authorities, governing bodies, and teachers concerned. The Board stated in the first paragraph of that circular that though it contemplated the application of the principles set out, it would be glad to consider any observations by a certain date before arriving at a final decision. The result of the observations is shown by Circular 1311; but surely it would have been very much better had the revision been made before the official issue of the first circular. As it is, there has been much difficulty and misunderstanding, and in some cases these provisional principles have already been acted upon and, in the light of the supplementary and explanatory circular before us, acted upon wrongly. We also feel that it would have been better to have cancelled Circular 1286 entirely and to have issued a new one amended on the lines of Circular 1311.

Map-making from Air Photographs.

Generalised Linear Perspective: Treated with Special Reference to Photographic Land Surveying and Military Reconnaissance. By J. W. Gordon. Pp. xvi + 184. (London, Bombay and Sydney: Constable and Co., Ltd., 1922.) 21*s*. net.

DURING recent years much attention has been paid to air-photography as a means of surveying; the present developments of the subject being chiefly due to the varied experience which was gained in the War. The method is still on its trial. There are certain conditions under which it promises to be successful, but no peace-time surveys of any importance have yet been carried out on this system. It is likely to be found of value in flat countries, and for maps on medium scales. Air-photo surveys have been suggested for the mapping of deltas, such as those of the Ganges, the Niger, and the Irrawaddy, and for the surveys of large native towns. The suggestion, made a few years ago, to map a hilly West Indian island in this way, was, probably wisely, "turned down."

The subject is thus, so far as concerns peace-time surveys, in a tentative stage, and any original contribution to the theory is most welcome. Mr. J. W. Gordon has made such a contribution in his book entitled "Generalised Linear Perspective." He gave a demonstration of his methods at the British Museum on March 25 last, and they have been described in popular terms in the *Times*. His ideas are thus being made well-known.

The main object of his investigation is to find a direct and simple system of converting an "inclined" air-photograph into a map or plan. In the most general case a photograph is taken in the air, at an unknown height above the ground, of country with unknown undulations and hills; the camera is tilted at an unknown angle and the direction of the tilt is also unknown. Nowadays, however, thanks to the insistence of the Air Survey Committee, it may be expected that the focal length of the lens will be known in every case, and also the position of the optical centre of the photographic plate.

The first step in Mr. Gordon's investigation is to choose a horizontal reference plane on which the plan of the ground is to be projected, at a distance from the nodal point of the lens equal to its focal length—a useful simplification, which, however, determines automatically the scale of the plan, so that photographs taken at different heights will be plotted on different scales.

Mr. Gordon introduces us to a new terminology, puzzling at first, and not always very clearly explained, but legitimate. It is necessary to learn the

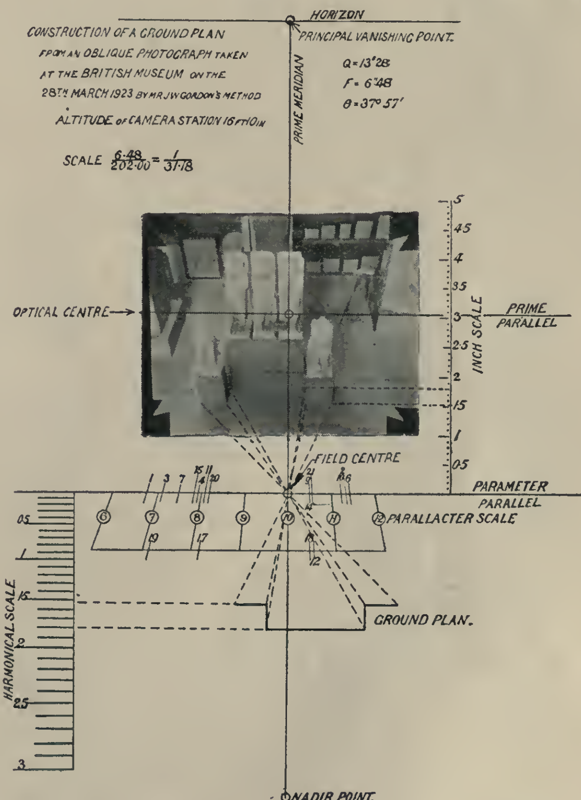
meaning of such terms as air-foot, margin, margin parallel line, carto-photo-field, parameter parallel, and so on. By taking measurements from the horizon on the photograph and from the "margin" on the reference plane (the margin being the intersection of the reference plane with a plane through the nodal point parallel to the plate), the invariable relation is obtained $H/p=p/h$, where $p=F \sec \theta$, F being the focal length, θ the tilt of the optical axis measured downward from the horizontal, h the distance measured to any point in the photograph from the horizon, and H the distance from the "margin" to the projection of that point in the reference plane, these distances being measured in the principal plane. Such distances have thus the reciprocal relation that if one set, say in the photo plane, is expressed as an arithmetical series, the other set in the reference plane will be expressed as a harmonical series.

Along the line of the intersection of the photo plane with the reference plane all magnitudes have, of course, the same value; and it also results from the perfect similarity of position of the two planes that, at the point on their intersection where it is cut by the principal plane (the vertical plane containing the optical axis), angles on the reference plane are correctly represented on the photograph. This point, which is sometimes known as the "isocentre," is called by Mr. Gordon the "field centre," and, as he remarks, this property of the identity in the two fields of any angle located in the field centre is the fundamental law of the perspective of angular magnitudes. The field centre is thus an appropriate origin for polar co-ordinates.

Let us now imagine the photograph to be hinged along the line of its intersection with the reference (or map) plane, and let it be turned round on this axis until it is in the map plane. The hinge (parameter parallel) is a line on which all lengths are truly represented in the photograph, and the field centre is a point in this line at which angles are truly represented. Distances measured at right angles to the hinge are connected by the expression $H/p=p/h$. For distances measured parallel to the hinge, we have $Y/y=p/h$ where Y is the ordinate of a point on the map, y that of a point on the photograph; or $Y/y=(X+p)/p$, where X is the abscissa on the map plane, measured at right angles to the hinge.

To make use of these expressions we must fix on the photograph the position of this hinge line, which is parallel to the line of the horizon; and to do this we must draw the horizon. The distance between the hinge line and horizon is p. To fix the horizon, Mr. Gordon rediscovered, in the course of his investigation, a solution which he afterwards found had been given by Brook Taylor, of Taylor's Theorem, two hundred years ago. Thus, let there be three points in a line in the reference plane (or cartographic field), and let the known length of one segment be a and of the other b, the line lying in any direction. Let A and B be the lengths of the representations of these segments in the photograph. Then the distance, V, from the intermediate point of the three, on the photograph, measured along the given line, to the horizon, is $(a+b)AB/(aB-bA)$. This gives one point on the horizon and a second divided line will give a second point, so that the horizon can be drawn on the photograph.

Mr. Gordon also points out that it is possible, in a similar way, to identify the nadir point on a photograph, by making use of a vertical line on which three points have been marked at known distances from each other. From the nadir point, a line drawn through the optical centre, at a distance $2F/\sin 2\theta$ from the nadir point, gives the position of the principal vanishing point.



The accompanying illustration will serve to give an idea of the lines made use of by Mr. Gordon in constructing a plan from an oblique photograph. The method used was not precisely that which would be employed in survey work, but the diagram indicates the general principle. The height of the nodal point of the lens was 16 ft. 10 in. above the floor; the focal

length was 6·48 in. The optical centre of the photograph was known. In place of measuring the tilt, this was determined from the photograph; the joints in the floor gave the principal vanishing point, and the vertical lines the nadir point. If the distance between these two points is Q, then the angle of tilt $=\frac{1}{2}\sin^{-1}2F/Q$; in this case the tilt worked out at $37° 57'$. The distance of the parameter parallel and field centre from the principal vanishing point is p. If an upright arithmetical scale, measuring from the parameter parallel, is drawn alongside the photograph, this will be represented on the plan by a harmonical scale. Or, by computation, if h is the perpendicular distance, from the horizon, of any point in the photograph, the distance of the representation of this point, measured from and at right angles to the parameter parallel, will be $p(p-h)/h$. The intersection of parallels so obtained with rays drawn through the "field centre" will give the positions of the points on plan.

So far, the system is essentially a point by point method of plotting. It will, no doubt, often be found of real value, and the neatness and simplicity of the few calculations required recommend it, especially in those cases in which the plate is considerably inclined to the horizontal. It is not so convenient when the plate is nearly horizontal, and it would be a mistake to suppose that it enables photographs to be converted into plans which could not have been so converted by the methods used before its publication. The data required remain the same. The method has the minor disadvantage that the plotted plan will depend for its scale on the height of the camera, so that a mosaic of photographs will give a series of plans on different scales. But this is not an important objection.

Mr. Gordon's book is somewhat troublesome reading, and the student will probably find the clearest explanation of his methods and terminology in the chapter entitled "Recapitulation." But the book contains original matter and will take its place in the list of authorities which those interested in the subject must study.

Mr. Gordon states in his preface that recent developments of methods of military reconnaissance have given "an urgent call" for a generalised system; he writes of "the authentic rule which the soldiers of 1915 so urgently desiderated"; he states that he provides the solution of the mathematical problem "that grievously vexed the soldiers during the years of the Great War"; and he indicates generally that, in his opinion, the want of a knowledge of Taylor's rule, rediscovered by him, prevented the survey staffs of the armies from making effective use of air-photographs in the construction of military maps. This does not do justice to the work of the survey staffs. The writer of this notice is satisfied that if Mr. Gordon's book had been available during the War, it would have made no material difference. Mr. Gordon provides a new method of plotting; but several other thoroughly sound methods were in use.

No difficulty was, as a fact, experienced in converting air-photographs into plans by the methods actually used. It is not the case that oblique photographs were avoided on account of any supposed difficulty in making use of them. This is a mistaken idea. Photographs departing considerably from the horizontal were, in general, avoided, because it was necessary to get vertically, or nearly vertically, over the enemy, to find out what he was doing and to avoid the interference of cover. The photographs so obtained, although taken on plates that were only inclined to the horizontal some 3° or 4° on the average, were not treated as plans, but were converted into plans by perfectly orthodox methods. There is an admirable exposition of the matter by Lt.-Colonel M. N. MacLeod entitled "Mapping from Air Photographs," published by H.M. Stationery Office. All who are interested in the subject may be advised to read this. They should also read Mr. Gordon's instructive book, and they will then see that there are several ways of killing this particular cat.

Two other matters call for special comment, namely, contouring from air-photographs and the use of a vertical base. As to the first, the theoretical difficulties are not formidable, but the practical difficulties are, and neither Mr. Gordon nor any one else has yet properly solved them. At present Mr. Gordon's suggestion is as good as any, and that is to plot two maps of the same piece of ground from two different positions of the aeroplane, and determine the heights, point by point, by means of the varying parallaxes. This agrees with the advice of Lt.-Col. MacLeod, which is to prepare prints of two photographs, separately taken, "rectified" to a chosen horizontal plane, and from one of them to make a tracing which can be superimposed on the other, for comparison of parallaxes. But even this method will fail when the points are not visibly marked, and would be inapplicable to the contouring of an ordinary hill-side. Perhaps something might be done by stereoscopic plotting from two parallel plates simultaneously exposed from the extremities of the wings of an aeroplane.

With regard to the use of a vertical base, Mr. Gordon points out that it is theoretically possible, given, in the oblique photograph, a vertical line which has three points marked on it, at known distances from each other, to determine the nadir point on the photograph, and, the optical centre being known, the tilt and parameter parallel can be found. But the practical

difficulty of arranging for such a vertical line to appear in the photograph would appear to be considerable. Ropes suspended from small balloons are liable to be deflected from the vertical by local air movements, and the system would involve additional apparatus. The suggestion is an ingenious one, however, and deserves to be tried.

It should be noted, in conclusion, that recent[1] experiments by Prof. Melvill Jones and Maj. J. C. Griffiths have shown that it is possible to fly on such an even keel that the photographic plate shall seldom be inclined to the horizontal as much as 2°. This would result in linear errors, on the uncorrected photograph, of less than $1\frac{1}{2}$ per cent. In many cases this class of plotting error can be permitted for detail, and in such cases no knowledge of, or correction for, tilt would be required, and all that would be necessary would be to know the length of one line on the ground to give the scale. There would be a great saving of time and expense in plotting the map and in fixing ground points, and, for the more rapid kinds of reconnaissance, in flat or undulating country, progress may be hoped for in this direction.

[1] See Nature, May 26 and June 2, 1923.

Light and Health.

Heliotherapy. By Dr. A. Rollier. With the Collaboration of Dr. A. Rosselet, Dr. H. J. Schmid, Dr. E. Amstad. (Oxford Medical Publications.) Pp. xxii + 288. (London: Henry Frowde and Hodder and Stoughton, 1923.) 25*s.* net.

ALTHOUGH it has long been known that certain radiations have a powerful action on physiological processes, it is only in recent years that much attention has been given to the subject as it affects the higher animals. Apart from the mechanism of carbon assimilation in the green plant, our eyes have been mainly directed to the lethal effects of ultra-violet rays, and, more recently still, to those of X-rays and of radium. The author of the book before us was one of the first to appreciate and to make practical use of the *beneficial* action of sunlight. Dr. Rollier's work at Leysin has been made familiar to readers of Nature by the recent lecture given at the Royal Institution by Dr. Saleeby, and the reviewer cannot do better than refer those who wish for further information, with abundant and deeply interesting illustrations, to this translation of Dr. Rollier's book. Forewords are contributed by Sir Henry Gauvain and Dr. Saleeby, while special chapters are included on the scientific basis by Dr. Rosselet, on the use of X-rays in the control of the progress of the treatment by Dr. Schmid, and on the adjuvants of heliotherapy by Dr. Amstad, who also adds a chapter on non-tuberculous diseases.

The book itself is a most fascinating one and will be found full of interesting details, not merely of clinical nature, but of value to the student of science, art or morals. It should have a wide circulation, and the only criticism that I am inclined to make is that the price seems rather high. I refer to this now in order not to end on a discordant note. It is difficult to see what might be the cause of this high cost, and it is to be feared that it may tend to restrict the sale of a book which should be in the hands of everyone who has at heart the happiness of his fellow-men, and especially of those who love children. I wish particularly to direct attention to the wide general interest of the contents, because the title might give the mistaken impression that it is a purely medical work.

The scientific reader will notice that we have much to learn as to the physiological action of light, and it will probably serve the best purpose if I devote the space available to a brief reference to the facts brought out by Dr. Rollier's work and to the gaps which await the results of further investigation, much of which can be done in the laboratory.

In the first place, we must distinguish between the effects of rays of different wave-lengths. In rickets, it is a limited region of the ultra-violet that is effective; in tuberculosis, we have no precise knowledge of the important region, except that the heat rays of long wave-length have to be guarded against. The necessary exposure cannot be tolerated except under the cooling influence of alpine air or of sea-bathing. Recent work tends to show that the rays of the red end of the spectrum may neutralise the benefit of the shorter wave-lengths. There is scope for investigation of the action of optical sensitisers, when atmospheric conditions cut off the active rays. The red algæ give us an example to follow. It is also clear that exact measurements and records are needed of the rays of various wave-lengths present in the sun's light in different places and at different times of the year and day.

Next, we may note that Dr. Rollier has from the first been aware of the fact that the direct action of the rays on a diseased organ is not what is required. Exposure of the skin in any situation suffices. It is natural to draw the conclusion that some photo-chemical product is sent from the skin into the circulating blood. But we have as yet no actual proof of this, and there are other possibilities which cannot be entered into here. In any case, we are shown that the skin has some important functions hitherto unappreciated.

Then there is the remarkable fact that it is only those individuals whose skin takes on the well-known brown pigmentation after exposure to the sun who

react rapidly. We do not know the meaning of this—whether it is merely an unessential reaction which is associated with other characteristics of the individual, whether the brown pigment is an optical sensitiser, or again whether it is a screen to cut out injurious rays.

A further question requiring more investigation is the increase in oxidative metabolism. There may be reflex effects to muscle, or a direct result of warming of the blood (Sonne), or it may be simply a reaction to the cold air. It appears that the muscles of tuberculous patients may grow in size and firmness, although they may be but little used.

The general effect of the treatment is not to be overlooked, especially in the case of children brought into bright and interesting surroundings.

Although it is in the direct cure of disease that the most striking effects of sunlight are seen, it is impossible to believe that the physiological processes at the basis of these effects play no part in the prevention of disease. Dr. Rollier has an interesting chapter on his "École au Soleil," established for children predisposed to tubercular disease. Exposure to sunlight must, moreover, be of the greatest importance in maintaining normal health—a fact far too little taken to heart.

There are many points of practical importance brought to our notice by this book. I may conclude with mentioning two of these. Dr. Rollier shows that pulmonary cases do quite well, contrary to the view often expressed. Care must be taken to avoid overheating and exposure to the sun must be very gradual, with adequate ventilation. The other point is the necessity for keeping the atmosphere over our large towns and manufacturing areas free from the pollution of smoke.

W. M. BAYLISS.

Primitive Culture Analysed.

Early Civilisation: an Introduction to Anthropology. By Alexander A. Goldenweiser. Pp. xiv+428. (London, Calcutta, and Sydney: G. G. Harrap and Co., Ltd., n.d.) 15s. net.

DR. GOLDENWEISER has long been known for his acute criticism, in various journals, of the theories and constructive efforts of the most noted ethnologists; we therefore welcome in this introduction to anthropology an exposition of his matured views, though his book will but partly supply the need there is for a systematic treatise on ethnology.

The book consists of three parts: the first deals with a general sketch of the Eskimo, Tlingit and Haida, Iroquois, Baganda, and Central Australians, as illustrative of distinct civilisations, though in each case one of their respective cultures has been given more careful treatment than the others. Goldenweiser correctly states that "the only way to know early civilisation is to study it in the wholeness of its local manifestation." The various activities and beliefs of a people are so intimately interwoven that quite wrong inferences may be drawn if a custom is separated from its context and compared with an analogous custom isolated from another group. These five accounts afford material for future discussion; as the author states, other groups would have served as well, but these suffice for practical purposes without rendering the book unwieldy.

The second part deals with industry, art, religion and magic, and society, which are considered partly from the point of view of special cases and partly constitute a limited comparative survey. There is a great deal of valuable matter in this section, but there are also many aspects of culture that are not alluded to, possibly from lack of space. For example, the researches of A. R. Brown on various Australian tribes throw new light on Australian sociology, and what is often termed "soul substance" is not mentioned. In discussing diffusion *versus* independent development in early civilisation some valuable reflections are made. Graebner's views are slightly criticised, Elliot Smith is dismissed with scorn, but Rivers is dealt with at greater length, though some of his arguments are described as "highly artificial." The author concludes by saying "we must reiterate our former position that the diffusion of civilisation from tribe to tribe is but one of the basic factors in cultural advance, the other factors being human creativeness, resulting in the independent origination of new things and ideas," though elsewhere he says, "the civilisational rôle of borrowing is fundamental."

In the third part Dr. Goldenweiser discusses various theories of early mentality: those of Herbert Spencer, that the ghost is the corner-stone of early theology, that spirits are derived from ghosts, the nickname theory of animal and other cults; the views of Frazer on magic and its relation to science and religion, the origin of exogamy. He says that "Wundt approached the problem of primitive mentality with a far broader and deeper equipment in scientific method than did Spencer, Tylor, or Frazer. As a student of psychology he was proof against the allurements of a facile mode of interpretation of primitive thought, of which these authors are so often guilty. He discarded the crude rationalism of Spencer and Tylor. . . . The associationism of Frazer also collapsed before Wundt's critical onslaught," but even Wundt often failed "to escape the allurements of monogenetic derivations." Durkheim also receives very favourable consideration, though his "tremendous exaggeration of the import-

ance of social factors as contrasted with all others" is duly noted, and he "fails to do justice to the contribution of the individual to religious experience." He also disagrees with certain aspects of Lévy-Bruhl's views, and with Rivers in his criticisms thereon; he, like others, cannot accept Freud's Cyclopean family or his conception of totemism.

The last chapter on early life and thought is an admirable constructive effort on the part of the author, in which he ranges himself on the side of the French and German psychologists as opposed to British anthropologists.

As Dr. Goldenweiser freely criticises others, he cannot object to having a few of his own shortcomings pointed out. Buganda lies north and north-west of the Victoria Nyanza; we are told that "maize is perhaps the principal staple food" of the Baganda (p. 83), but Roscoe says no grain is grown and that plantains furnish their staple food. There are more varieties of Australian canoes than the two bark ones he refers to, and the dingo is not a wolf, but allied to the Indian dog. The decorative art of Australia is more varied than he imagines, and ceremonies for the multiplication of totemic animals are not confined to the Aranda, as he seems to imply (pp. 109, 281). Pile dwellings and tree houses have a more extended range than is indicated (p. 135). The great stone images of Easter Island are not "wooden idols" (p. 306). It is incorrect to describe Elliot Smith as a "follower" of Rivers; if anything, the reverse is nearer the mark. The statements are erroneous that "Man has never used man as a regular article of diet . . . we do not hear of the eating of relatives" (p. 396). Throughout the book the term "etching" is used for engraving or incising: etching is a definite technical process.

A. C. Haddon.

Sir Alfred Yarrow.

Alfred Yarrow: his Life and Work. Compiled by Eleanor C. Barnes (Lady Yarrow). Pp. xv + 328 + 78 plates. (London: E. Arnold and Co., 1923.) 10*s.* 6*d.* net.

LADY YARROW has given us a most interesting and genial account of the life and work of Sir Alfred Yarrow and has successfully portrayed, in happy and engaging style, a character which Smiles would assuredly have been glad to utilise in his examples of "Self Help," and to have included in his "Lives of the Engineers." She has succeeded in showing not only the shrewd business capacity of Sir Alfred, but also his remarkable ability to apply science to the needs of the great industry with which he was chiefly associated, especially in those branches in which he was in the front rank of pioneers for a very long period. His admiration for the attainments and discoveries of the man of science stands high, but it is equalled by his appreciation of the sound sense and fertility of resource of the skilful manual worker; and a perusal of the book will indicate the reasons for his being in the forefront of those who have derived advantage from the happy combination of the two.

Lady Yarrow shows that Sir Alfred, equipped with an abundance of scientific and general knowledge, was quick to perceive when the teachings of science or of handicraft, or both, could be brought to the aid of his problems, and, soon satisfying himself of the accuracy of his premises (generally by the help of homely but convincing experiment), he rapidly proceeded to successful solution, mostly with satisfactory and frequently with far-reaching results.

It has fallen to the good lot of many to have been associated with Sir Alfred in some portions of his comprehensive work; few, if any, can have been connected with the whole of the developments in shipbuilding and marine engineering in which he has taken such a prominent part, and this story of his life consequently contains much of interest that must be new to every individual reader, however intimate his acquaintance for a period may have been. To all such the book will be highly reminiscent, and naval engineers in particular will recall many exciting incidents of the trying times which marked the endeavour to get better than their best from the coal-fired boiler and the high-speed reciprocating engine, each in its special pandemonic environment. As described in the book, these experiences constituted a phase provoked by the demand for high speeds which necessitated the use of extremely light machinery, and they had to be endured to prepare the way for the engine-room conditions that we now enjoy—perfect peace with oil-fired boilers and turbines.

Sir Alfred Yarrow's part in the development of high-speed craft is generally well known, but the full extent of the part he took during the War is perhaps not so widely known. The chapters devoted to this portion of his work do not disclose the whole of his efforts, so remarkable in one of his advanced years, but they are sufficient to reveal his high sense of patriotic duty, and the versatility and value of his vigorous endeavours. He enjoyed the confidence of Lord Fisher in his work for the Navy, and amply proved that the confidence was justified.

But, in addition to his high professional reputation, Sir Alfred is esteemed for his kindly disposition coupled with more than an ordinary desire to help his fellow-men. The author's note at the end of the volume delineates this side of Sir Alfred's character in touching words,

and her interesting descriptions in the text of his principal philanthropic schemes supply further details. His own ideas of how to dispose of "a balance at the bank in excess of what is necessary" are given in Chapter XX., "The Convalescent Home," and are commended to readers, who will afterwards understand more readily the unique reasons for Sir Alfred's many generous benefactions during his lifetime.

Lady Yarrow has evidently compiled her work under some restraint, as more could be told both of Sir Alfred's professional success, and of his bounty, and his methods of encouraging others (for example, his recent munificent gift to the Royal Society is not mentioned in this book), but she has told enough to warrant Sir Alfred's claim that "his business life has been filled with sentiment and friendship." She is to be congratulated on the scheme, sequence, and style of the compilation, and she can be assured that her work will be highly appreciated by the very large circle of Sir Alfred's friends.

G. G. Goodwin.

Our Bookshelf.

Grundriss der allgemeinen Zoologie für Studierende. Von Dr. Alfred Kühn. Pp. viii + 212. (Leipzig: Georg Thieme, 1922.)

This is a wholly admirable text-book. We know of no book in the English language exactly like it, none that attempts so much within so limited a space, and, moreover, attempts it so successfully, with a due regard to the requirements of those for whom it is written and to the maintenance of a proper balance between the various parts of the subject. The book is divided into three approximately equal parts, the first giving a rapid survey of the morphology of each phylum of the animal kingdom, the second an account of the physiology of animals, and the third a review of the main principles of embryology and the problems of variation, heredity, sex, and evolution. The book concludes with a short bibliography of more advanced text-books and original memoirs to which the student can turn for more detailed information on any point.

In attempting to treat of the whole of the animal kingdom in 70 pages, the author may be thought to have essayed an impossible task. By confining himself to the broad and general characters of each phylum, without entering into details of any one type, however, and aided by an excellent series of diagrammatic figures, he has succeeded in giving an admirably clear account of each phylum. The book is intended for medical students, and, consequently, special emphasis is laid on parasitic forms throughout, without, however, overburdening the book in this way or losing the general perspective of the whole. The illustrations have been mainly drawn specially for this book. They are, in the majority of cases, schematic drawings, very clearly reproduced and excellently chosen for the purpose, and would make good wall diagrams for lecture purposes.

The point which most impresses us in this book is the excellent balance which the author has kept between the three broad divisions of zoology—morphology, physiology, and embryology—with its kindred problems. The general course given to first-year medical students is apt to be weighted too much on the morphological side; physiology is generally neglected, and very little consideration is given to the fundamental and general problems of zoology. We feel sure that a course on the lines so admirably sketched by Prof. Kühn would give the medical student a broader outlook on zoological subjects, would interest him more for its own sake, and would make abundantly clear to him the fundamental bearing of his zoology course on his future life's work. He would no longer regard zoology as a subject put into his curriculum for his ultimate confusion, to be got through with the minimum amount of work in the minimum time. With a little amplification, Dr. Kühn's book would serve as a basis for subsidiary one-year courses in zoology for science students.

Our Solar System and the Stellar Universe: Ten Popular Lectures. By the Rev. Charles Whyte. Pp. xi + 234 + 18 plates. (London: C. Griffin and Co., Ltd., 1923.) 10*s*. 6*d*. net.

The ten lectures which form the basis of this volume were delivered as the Thomson Lectures for the session 1919–1920 in connexion with the United Free Church College, Aberdeen. They provide a survey—fairly up-to-date and in general accurate—of the present state of astronomical knowledge, in a form suitable for the non-scientific reader, so far as it is possible to do so without the introduction of mathematics or of mathematical reasoning.

There are a few errors to which attention may be directed. The statement on p. 27 that "the theory now generally accepted as being the chief cause in the maintenance of the sun's heat, is that advanced by Helmholtz in 1853," is not correct. It is well known that this theory is not in accord with geological facts. Again, on p. 60, it is stated that a temperature of 750° F. at the surface of a planet corresponds to an intensity of the rays of the midsummer sun multiplied by 9. This is, of course, a fallacy. The rotation period of Mercury is not known with certainty, though from p. 61 the contrary would be inferred. It is certainly exceeding the limits of scientific truth to say, as on p. 151, that "we have every reason to believe that a number of planetary bodies, many of them exceeding in size our own solar satellites, travel round these suns in swift motion over enormous circumferences," while on p. 164 the sentence, "They (the Cepheids) are situated from us at enormously greater distances than those which up to now have been measured," requires modification. In dealing with the Martian canals, their possible subjective nature might have been mentioned. The detailed elementary calculations on pp. 61-2, 87-8 might have been omitted with advantage.

The book is well produced, with good paper and clear type. The plates have been carefully selected, and it is a pleasure to see them reproduced on well-glazed paper. Too frequently astronomical photographs lose much of their value when reproduced in popular works, through the use of inferior paper. The book can be recommended as one which will provide much interesting reading to those who, though without scientific training, are interested in astronomy.

H. S. J.

Some Questions of Phonetic Theory. By Wilfrid Perrett. Chapter 6: The Mechanism of the Cochlea. Pp. 39-80. (Cambridge: W. Heffer and Sons, Ltd., 1923.) 2*s.* net.

THIS section of Mr. Perrett's book is an attack on the resonance theory of hearing, and on all those who have written in support of it. It is his avowed object "to lay the yammering ghost of 'sympathetic resonance' in the cochlea" (p. 44). His criticisms of the resonance theory are under three headings: (1) An attack upon Helmholtz's theory of beats as he conceives it. The construction he puts upon Chapter VIII. of the "Tonempfindungen" is, in the reviewer's opinion, forced and unfair. (2) An uncorroborated personal experience of his own which leads him to the conclusion that the ear can distinguish two notes "in perfect physical unison" sounded simultaneously. (3) That speech sounds can terminate suddenly in a "voiceless-occlusion" consonant, consequently no "after vibrations" of the basilar fibres occur. Mr. Perrett quotes graphic speech records, but admits that the evidence drawn from them is inconclusive.

We gather that Mr. Perrett has abandoned the Wrightson theory in favour of a "travelling-bulge" theory on the lines of those of Meyer and ter Kuile, but he does not appear to have brought forward any additional evidence in support of this view. He tells us that the preceding four chapters of his book have been received "with gratuitous contumely in certain quarters" (p. 59). We cannot help thinking that his manner of conducting a controversy may have been responsible to a certain extent for the treatment his work has received. G. W.

The Americas. By J. Bruce. (The "Explorer" Geographies). Pp. viii+216. (London: G. Bell and Sons, Ltd., 1922.) 3*s.*

A NEW note is introduced into elementary geographical teaching by this volume, which appears to be the first of a series. After an introductory chapter on map-reading, there are several chapters describing the way in which the American continent was discovered and opened up by Europeans. The sections are vividly written and cannot fail to interest, although the paragraphs and map dealing with Arctic Canada and the North-west passage would bear some revision. Then follows a general geographical survey of the Americas. Eight double-page plates with full descriptions are a notable feature, and there are in addition several sketch maps and two coloured orographical maps. The list of books for students' reading is useful, but might well be extended. The book as a whole gives a far more vivid picture of North and South America than the more formal analytical text-books succeed in doing. R. N. R. B.

Elements of Glass-blowing. By Dr. H. P. Waran. Pp. ix+116. (London: G. Bell and Sons, Ltd., 1923.) 2*s.* 4*d.* net.

DR. WARAN's book deals in a clear and practical way with many things which a research student will find that he requires to know. The ability to put together and to repair simple glass apparatus is one of the things which he should gradually acquire, and this book will be found a useful guide in this direction. It is very doubtful whether the laboratory worker will find it desirable to make his own stopcocks or Dewar vessels; the time spent on such work would usually be more profitably applied in research, but in places where apparatus is not easily obtained it may be quicker to make it. As a general rule, unless one has become very proficient in glass-working, it is usually cheaper and quicker to leave complicated things to the professional man.

The Wonders of the Stars. By Joseph McCabe. Pp. ix+114+4 plates. (London: Watts and Co., 1923.) 3*s.* net.

THE author has written a series of volumes on various phases of evolution; the present book belongs to the series, and discusses the light that has been thrown on stellar and planetary evolution by the discoveries of the last half-century. As an illustration of the difficulty of keeping up-to-date in discussing the status of the spiral nebulæ, some of the views of leading astronomers in favour of the "island-universe" theory that are quoted in the book have already been modified by the discovery of their rapid rotation.

While a few sentences here and there might be picked out for criticism, chiefly the statement of matters of conjecture as facts, on the whole the picture given of our present knowledge of the universe appears to be correct, and as complete as can be expected in the space of 112 pages. We sympathise with the author's appeal for a general agreement among astronomers as to the meaning of a "billion." A. C. D. C.

Astronomie: Grösse, Bewegung und Entfernung der Himmelskörper. Von A. F. Mobius. 13 Auflage, bearbeitet von Prof. Dr. Hermann Kobold. Teil 2: Kometen, Meteore und das Sternsystem. (Sammlung Göschen Nr. 529.) Pp. 128. (Berlin und Leipzig: W. de Gruyter und Co., 1923.) 1*s.*

THIS little book has three chapters dealing with comets and meteors, the fixed stars, and cosmogony respectively. This restriction of subjects enables each to be treated pretty fully, in spite of the small size of the volume. The information is brought up-to-date, and includes recent comets, the Giant and Dwarf theory, and a discussion of the planetesimal theory. The star-maps give the positions of all stars of magnitude 5 or brighter down to south Decl. 45°. A. C. D. C.

Tracks of British Animals. Edited by H. Mortimer Batten. (Edinburgh: W. and A. K. Johnston, 1923.) 4*s.* net.

THIS publication takes the form of a chart, 20 in. × 30 in., depicting in life-size the spoors of the commoner British wild animals and of domestic animals for comparison, with brief explanatory notes by the editor. The diagrams are boldly and clearly printed and the chart should be of the greatest use for the teaching of nature study in schools and for the instruction of Boy Scouts and Girl Guides in the craft of the country-side. The omission of a figure of the track of a dog is one that should be made good in a future edition.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Photographic Plates for the Extreme Ultra-Violet.

IN recent years there have been a number of attempts to improve the photographic methods, perfected by Schumann, used in the investigation of the ultra-violet, so far without any very striking results.

Recently Mr. David Mann and I have been making some experiments with the daguerreotype process. The results, though interesting, are so far of no great practical value. It is not difficult to prepare a surface which will be very sensitive in the region about wave-length 1850 Å.U., and on two or three occasions we have obtained records extending to wave-length 584 Å.U., but in general the behaviour of the plates in the extreme ultra-violet is capricious and unsatisfactory.

Duclaux and Jeantet (*Journal de Physique*, ii., 1921, p. 154) have described a way of "Schumannising" an ordinary dry plate by treating it with sulphuric acid, and recently Aston has referred to the same process. M. Duclaux has been so kind as to send me some specimens of the results he has obtained. He informs me, however, that he prefers another method which he and his colleague have discovered, described in their article just cited. His experiments were confined to the region of the spectrum which may be investigated with a quartz prism spectrograph; I have continued them into the extreme ultra-violet.

The procedure is extremely simple. A fast commercial photographic plate (I have employed a "Seed 30") is coated with a thin film of a colourless paraffin oil. It is then exposed in the usual way in a vacuum spectroscope, the oil is removed with acetone and the plate is developed. The results are nearly, though not quite, as good as those which I have obtained with the most sensitive Schumann plates prepared according to the old method; it is quite easy to get a record of the strong helium line at λ584 Å.U.

The success of the process evidently depends on fluorescent action; I have tried a number of different kinds of oil, and I find that "Nujol," a very pure oil sold in this country for medical purposes, yields good results.

I feel sure that this discovery of Duclaux and Jeantet will prove a real blessing to all spectroscopists who work in the extreme ultra-violet.

THEODORE LYMAN.

Jefferson Laboratory, Harvard University,
June 28.

The Presence of Urease in the Nodules on the Roots of Leguminous Plants.

AFTER the discovery of urease in the Soya bean by Takeuchi in 1909, the presence of this remarkable urea-splitting enzyme was soon recognised in the seeds of many leguminous plants. On the other hand, while the occurrence of the enzyme in seeds from widely different varieties of plants has been recorded in recent years, its absence from the seeds of several Leguminosæ has also been noted.

So far as we have been able to ascertain, the peculiar root nodules of leguminous plants have not hitherto been tested for urease. Experiments carried out in this laboratory in conjunction with Mr. J. V. Collins have revealed the presence of the particular enzyme in all the cases examined. Crushed nodules taken from the well-washed rootlets of *Trifolium procumbens*, *T. pratense*, *T. repens*, *Vicia sativa*, *Medicago sativa*, *Galega officinalis*, various lupins, and the garden pea, were placed separately in a two per cent. solution of urea (sterilised by saturation with toluene) to which a few drops of neutral phenol-red solution had been added as indicator. A purple-red colour, due to ammonia generated from the decomposition of urea, was gradually developed in the solutions, after they had been maintained at 55° for about an hour. Several control experiments showed that ammonia was not generated in the absence of urea, and that the solution of the latter alone did not change the colour of the indicator under the above conditions. Also, rootlets not bearing nodules, and roots taken from plants belonging to several different natural orders, failed to give any evidence of the presence of urease. Judging from qualitative experiments, nodules from the white and the yellow tree lupin appeared to be the most active of those examined.

From these observations it must be concluded that the nodules on the roots of leguminous plants possess an additional function to the one which they have been known to perform since Hellriegel's discovery. While we have not found urease in any roots devoid of nodules, clear evidence was obtained of its presence in the cylindrical tuberous growths developed from the rootstock of the lesser celandine (*Ranunculus Ficaria*). This is the only case so far in which the enzyme has been detected in the adjunct of a root outside the leguminous family of plants.

An interesting demonstration of the presence of the enzyme can be made without crushing the nodules. The entire root cut from a young pea plant, or preferably from a young lupin, as it usually carries larger nodules, is immersed in a solution of urea containing a liberal supply of the indicator (neutral phenol-red). The action of the enzyme is allowed to continue until the solution has attained a rich purple-red colour, which of course requires a much longer time than if the nodules had been crushed. The root is now removed from the solution, rinsed for a few moments under the tap and then placed in water to which a few drops of the indicator have been added. The diffusion of alkaline solution from nodules into the outer liquid can be readily observed by the zone of colour which forms in the solution directly round the nodules.

While the first part of this experiment illustrates the relatively feeble activity of the nodules *in situ*, if the root be now washed in running water until the colour of the indicator is no longer affected, it will be found that when immersed again in a solution of urea the rate at which the latter is decomposed will be much greater than when the nodules were tested originally. This obviously suggests that urease is produced within the nodules during contact with the urea solution. Under natural conditions the micro-organisms present in the nodules are probably concerned in the generation of the enzyme as required. In our experiments the antiseptic power of toluene was apparently insufficient seriously to affect their activity. Pending a more extended investigation of the subject, our preliminary observations seem worth recording.

E. A. WERNER.

University Chemical Laboratory,
Trinity College, Dublin.

Solar Activity and Atmospheric Electricity.

DR. CHREE in a recent paper,[1] giving the results of his investigation based on the Kew atmospheric-electric data, reaches the following interesting conclusion, as stated in his abstract: "The results obtained are on the whole not incompatible with Dr. Bauer's conclusion, but they indicate that if a relationship of the kind supposed exists, the sun-spot influence must be very much less in the case of atmospheric electricity than in that of terrestrial magnetism." The conclusion[2] referred to by Dr. Chree is that the potential gradient of atmospheric electricity apparently varies during the sun-spot cycle, increasing with increased sun-spot activity, and that the diurnal range of the potential gradient of atmospheric electricity, like the diurnal range of terrestrial magnetism, increases with increased sun-spot activity.

I fully agree with Dr. Chree that if there is a relationship between solar activity and atmospheric electricity, it ought to turn out to be a world-wide phenomenon, just as in the case of the recognised relationship between solar activity and terrestrial magnetism. However, this fact is to be kept in mind, that disturbances, because of local conditions, play a far more predominant rôle in atmospheric electricity than in terrestrial magnetism, and may in fact be of such a character as to mask completely any world-wide effect. Accordingly, in atmospheric electricity a very careful selection of stations is necessary for the study of world phenomena. It thus may turn out that one very favourably located station, such as the Ebro Observatory at Tortosa, Spain, upon the excellent and consistent observations of which my first conclusions were chiefly based, may lead to a more certain result than a dozen unfavourably located stations.

One of the best criteria for judging the unfavourableness of a station is the ratio c_2/c_1 of the amplitude of the 12-hour and 24-hour waves, respectively, of the potential gradient; the smaller the ratio the more readily does the station show "universal" or "terrestrial" results. This ratio at Kew is one of the largest of any of the stations known to me; it varies between winter and summer from about 1 to 5, and on the average for the year is 2 against 0·8 for Ebro, 0·7 for Eskdalemuir, and 0·25 for the oceans. Furthermore, the absolute value of the potential gradient at Kew is more than twice the average normal value for the region of the earth from 60° N. lat. to 60° S. lat. However, in spite of the disturbed character of the Kew station, Dr. Chree has succeeded in getting results which he says are not incompatible with mine, and I shall show how, by the recognition of another variation to which atmospheric electricity appears to be subject, the validity of his results respecting the sun-spot effect may be enhanced.

Every series of carefully made and undisturbed observations, extending over a period approximating a sun-cycle or more, has received investigation and definite results have, in general, been obtained. A notable exception is Potsdam, where, because of severe climatic disturbances, instrumental changes, and changes in reduction factor, the extensive series of observations at this station unfortunately is subject to discontinuities and therefore cannot safely be utilised for the detection of a sun-spot effect. For the present sun-spot activity, as indicated by the Wolf or Wolfer sun-spot number, is taken as a measure of solar activity, the possible influence of which upon atmospheric electricity is to be investigated. Other measures of solar activity—for example, prominences—are likewise included in the complete investigation.

Suppose we have for a series of years the mean annual values of the potential gradient P in volts per metre, as resulting from continuous registrations throughout the year and based only on electrically undisturbed days, without negative potential. Let P_m be the mean value of P for the entire series corresponding to the mean date T_m, and let S_m be the mean annual sun-spot number; then with fair approximation a formula of the following type is found to hold:

$$P = P_m + s(S - S_m) + t(T - T_m). \quad . \quad . \quad (1)$$

The coefficient s represents the change in P corresponding to one sun-spot number, and t represents the time-effect or annual change in P dependent, apparently, upon the average character of the particular sun-spot cycle in which the series of P-observations happens to occur.

For nearly every series discussed thus far, when the station is fairly free from pronounced local or climatic disturbances and the annual values of P have been derived from electrically-undisturbed days, the coefficient s is found to be positive and averages about 0·30 per cent. of P_m for the mean of the year; hence, if the sun-spot development from minimum to maximum is 100 numbers, *the potential gradient* P *suffers an increase from the year of minimum sun-spot activity to the year of maximum sun-spot activity of about* 30 *per cent. of* P_m. (See Table 1.)

The value and sign of the coefficient t may depend upon whether the sun-spot cycle in which the P-series occurs is below or above average development. Thus the present cycle, beginning with the year 1913 of minimum sun-spot activity, is above average development; hence t turns out to be negative, as shown in Table 1. No such high mean annual sun-spot number as 103·9 for 1917 has occurred since 1870, when S was 139·1. How t may vary with cycle, and s with season of year, will be discussed in the complete paper which is to appear in the September 1923 issue of *Terrestrial Magnetism and Atmospheric Electricity*.

The values of s and t, expressed both in percentages of P_m and in volts per metre, as determined by the method of least squares, will be found given in Table 1 for three observatories, from Spain to Scotland, and the mean epoch 1916. The third and second columns from the end of Table 1 contain the mean square errors, μ_o and μ_c, obtained respectively, first on the assumption that the departures of P from the mean value P_m represent errors of observation, and secondly that formula (1) applies. It will be seen, from a comparison of the figures in the two columns, that by the application of the corrections (sun-spot effect and cycle or time effect) a very much better representation of the observed values of P is obtained than by the arithmetical mean P_m.

The last column, r_s, contains the correlation coefficient between potential gradient and sun-spot activity after the application of the corrective term $-t(T - T_m)$ to the observed values of P. It will be observed that, in general, the coefficient so nearly approaches unity, especially for Ebro and Eskdalemuir, as to leave scarcely any doubt of a definite relationship between the potential gradient of atmospheric electricity and sun-spottedness. By the recognition of the t-change, which is similar in its effect to the secular change in terrestrial magnetism,

[1] "A Supposed Relationship between Sun-spot Frequency and the Potential Gradient of Atmospheric Electricity," Proc. Phys. Soc., London, vol. 35, Part 3, April 15, 1923, pp. 129-136.
[2] *Terr. Mag. and Atm. Elec.*, vol. 27 (1922), p. 30; see conclusion *f*.

except that it is of shorter period and seems to vary from cycle to cycle, Dr. Chree's correlation coefficient for the Kew series 1911 to 1921 is increased from 0·55 to 0·77, and for the less regular series 1898 to 1909 from 0·24 to 0·62.

TABLE 1.—RELATION BETWEEN ANNUAL POTENTIAL GRADIENT OF ATMOSPHERIC ELECTRICITY AND ANNUAL SUN-SPOT ACTIVITY.

Observatory.	Period.	Weight.	T_m.	S_m.	P_m.	s.	t.	s.	t.	μ_o.	μ_c.	r_s.
					Volts per m.	Volts per m.	Volts per m.	Per cent of P_m.	Per cent. of P_m.	Volts per m.	Volts per m.	
Ebro . .	1911–21	2	1916·5	39·6	113	+0·35	−3·08	+0·31	−2·73	±11·1	± 4·2	0·94
Kew. . .	1911–21	1	1916·5	39·6	330	+0·65	−4·29	+0·20	−1·30	±25·9	±18·5	0·77
Eskdalemuir	1912–19	1	1916·0	45·8	258	+0·65	−4·66	+0·25	−1·81	±17·4	± 8·7	0·90

It will be instructive to show (Table 2) for a favourable case, Ebro, the application of formula (1). We have for this station, if $\Delta P_o = (P_o - P_m)$ represents the observed quantity and ΔP_c similarly the computed quantity, expressed in percentages of $P_m = 112·6$ volts per metre :

$$P_c - P_m = 0·313(S - 39·6) - 2·73(T - 1916·5),$$

or

$$\Delta P_c = 0·313\Delta S - 2·73\Delta T. \quad . \quad . \quad . \quad (2)$$

TABLE 2.—COMPARISON OF OBSERVED AND COMPUTED VALUES OF POTENTIAL GRADIENT AT EBRO OBSERVATORY, 1911–1921.

No.	T.	S.	P_o (Obs'd).	ΔP_o.	ΔP_c.	P_c (Comp'd).	$P_o - P_c$.	ΔP_o.	$s\Delta S$.	$t\Delta T$.	ΔP_c.	$\Delta P_o - \Delta P_c$.
			Volts per m.	Volts per m.	Volts per m.	Volts per m.	Volts per m.	Per cent. of P_m.	Per cent. of P_m.	Per cent. of P_m.	Per cent. of P_m.	Per cent. of P_m.
1	1911·5	5·7	116	+ 3	+ 3·0	116	0	+ 3·0	−10·5	+13·6	+ 2·7	+0·3
2	1912·5	3·6	113	0	− 0·7	112	+1	+ 0·4	−11·1	+10·9	− 0·6	+1·0
3	1913·5	1·4	110	− 3	− 4·8	108	+2	− 2·3	−12·1	+ 8·2	− 4·3	+2·0
4	1914·5	9·6	109	− 4	− 4·7	108	+1	− 3·2	− 9·3	+ 5·5	− 4·2	+1·0
5	1915·5	47·4	111	− 2	+ 5·2	118	−7	− 1·4	+ 2·3	+ 2·7	+ 4·6	−6·0
6	1916·5	57·1	121	+ 8	+ 5·7	118	+3	+ 7·5	+ 5·5	0·0	+ 5·1	+2·4
7	1917·5	103·9	130	+17	+19·3	132	−2	+15·5	+20·2	− 2·7	+17·1	−1·6
8	1918·5	80·6	126	+13	+ 8·0	121	+5	+11·9	+13·0	− 5·5	+ 7·1	+4·8
9	1919·5	63·1	110	− 3	− 1·5	111	−1	− 2·3	+ 7·3	− 8·2	− 1·3	−1·0
10	1920·5	38·7	107	− 6	−13·0	100	+7	− 5·0	− 0·2	−10·9	−11·5	+6·5
11	1921·1	24·7	86	−27	−21·0	92	−6	−23·6	− 4·6	−13·6	−18·6	−5·0

Let us take, for example, the change in the observed values of the potential gradient P_o between 1917 (year of maximum sun-spot activity) and 1921, as shown in Table 2. The observed change (decrease) at Ebro amounted to 39 per cent.; the computed decrease, according to formula (2), is 36 per cent.; 25 per cent. being contributed by the sun-spot term and 11 per cent. by the cycle or ΔT-term (see columns 9, 10, 11, and 12). That this remarkable decrease at Ebro between 1917 and 1921 was a world-wide phenomenon, besides being corroborated by Eskdalemuir and Kew, is further shown by the fact that the results of the *Carnegie* potential-gradient observations on the oceans, all instrumental and reduction constants having been most carefully controlled throughout the various cruises of the *Carnegie*, gave a mean value for 1921·5 which was about 30 per cent. less than the corresponding value for 1917·5.

There are no such correspondingly large changes in terrestrial magnetism during a sun-spot cycle as have just been shown to occur in atmospheric electricity. According to my 1918 investigations [3] an increase of 100 in the sun-spot number would correspond to a decrease in the intensity of magnetisation of the earth of about 0·1 per cent., whereas for an increase of 100 in the sun-spot number the normal potential gradient of atmospheric electricity was increased about 30 per cent.

The investigations thus far would indicate that the *electric conductivity* λ does not vary with sun-spot activity in the same marked degree as does the potential gradient P; hence, as the current density of the vertical current is $i = \lambda P$, we may say, with high degree of certainty, that the vertical conduction current increases with increased sun-spot activity at the rate of about 3 per cent. per 10 sun-spot numbers. The bearing of this most interesting fact upon theories of the origin and maintenance of the earth's negative electric charge needs no elaboration here.

But of equal importance with the sun-spot effect to theories is the cycle effect, which indicates that the earth's negative charge, even if all periodic variations and sun-spot effects are eliminated, is not maintained constant but may progressively, from year to year, show in one cycle a steady diminution, and in another a steady increase. During the present cycle, beginning with the year of minimum spottedness, 1913, the total decrease may be such that the potential gradient at Ebro in the approaching year of minimum, 1923 or 1924, may be about 30 per cent. less than in the minimum year of 1913, when the observed value was 110 volts per metre. But, as already intimated, the cycle effect may not always be a diminishing one. I hope to study the variations in t more exhaustively by utilising all past data obtained with the requisite care.

Lack of space will not permit describing here in detail the various examinations already made concerning the *effect of sun-spot activity on the periodic variations of the potential gradient of atmospheric electricity*. Dr. Chree in his paper cites the results drawn by me from a Fourier analysis of the diurnal variation of P at Ebro for the period 1910 to 1920, and he finds a correlation coefficient of 0·72; if account be taken of the cycle effect, which is also evident here, as the diurnal variation is a function of the absolute value of P, then the correlation coefficient is 0·96. The analysis has been extended so as to include the data for 1921, which have become available since the 1922 paper.

In my 1921 investigations, which Dr. Chree apparently overlooked, I investigated the relationship between the *range* of the diurnal variation of the potential gradient at Ebro and sun-spot activity, and found that the sun-spot variation in the diurnal range between minimum and maximum was about 25 per cent., and that it increased with increased sun-spot activity.[4] With the aid of a similar formula to (1), and taking the Ebro series 1911–1921, the value of s turns out to be +0·31 for the mean of the year; *i.e.* an increase in the sun-spot number of 100 between minimum and maximum, which was about the case for the present cycle, was accompanied by an increase of 31 per cent. in the diurnal range at Ebro. A similar result is found for the Kremsmünster series, 1903–1910. The average corre-

[3] *Terr. Mag. and Atm. Elect.*, vol. 23 (1918), p. 63.

[4] *Terr. Mag. and Atm. Elec.*, vol. 26 (1921), p. 68, conclusion *b*, and Fig. VII., fifth curve.

lation coefficient for the sun-spot effect on the diurnal-variation (range, average departure, Fourier combined amplitude) of the potential gradient for various stations is about 0·8; for Ebro and Eskdalemuir it exceeds 0·9. The reason that Dr. Chree gets somewhat unsatisfactory results from certain diurnal data at Kew is partly because of the fact, already mentioned, that Kew is not a favourable station for the most successful study of world effects. However, applying a formula similar to (1) to the Kew series 1898–1909, Dr. Chree's correlation coefficient for the sun-spot relation of his quantity c_r (combined amplitude of the 24-hour and 12-hour waves of the Fourier series) is increased from 0·46 to 0·77; $s = +0{\cdot}50$ per cent., and $t = -2{\cdot}11$ per cent. of c_r.

The *sun-spot influence is also shown in the annual variation of the potential gradient at Ebro*, for the period 1910–1921; the correlation coefficient is 0·71.

General Conclusion.—The relationship between sun-spot activity and atmospheric electricity turns out to be, for locally undisturbed stations, as definite as in the case of terrestrial magnetism; the sun-spot influence on the periodic variations of the atmospheric potential-gradient is, in general, as great as on the periodic variations of terrestrial magnetism; and as concerns the effects on the absolute values, the sun-spot influence is about 300 times greater in atmospheric electricity than in terrestrial magnetism. The potential gradient of atmospheric electricity, and, presumably, the earth's total negative electric charge, is furthermore subject to an annual or secular change, which may vary in magnitude and sign from one sun-spot cycle to another.

LOUIS A. BAUER.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington,
Washington, D.C., June 7.

Use of Yeast Extracts in Diabetes.

IN a previous letter to NATURE of March 10 (111, p. 327) we stated that we had obtained from yeast an insulin-like substance which had the effect of lowering the blood sugar of normal animals. Later we described the beneficial effect of this extract on some cases of diabetes mellitus (*Brit. Med. Journ.* i. p. 711, 1923). We soon found that the activity of the extract from different samples of yeast varied very widely. The results of these experiments will be published at a later date in conjunction with Dr. H. B. Hutchinson. In this connexion it is of interest to note that Collip (Proc. Soc. of Exp. Biol. and Med., 20, p. 321, 1923) reports numerous failures before he succeeded in obtaining an active extract from yeast, and later Funk and Corbitt (Proc. Soc. of Exp. Biol. and Med., 20, p. 422, 1923) have met with similar variability.

We have recently obtained from the action of micro-organisms other than yeast extracts which have a very considerable power of lowering the blood sugar of normal animals to a point where convulsions occur. That the convulsions were not due to a toxic effect is shown by the fact that they were relieved by injection of glucose. The extract like that from yeast caused the blood sugar to be lowered for a much longer time than when insulin was used. Whether these extracts will be of practical importance remains to be decided. Experiments are being directed to this end.

L. B. WINTER.
W. SMITH.

Biochemical Laboratory, Cambridge,
July 20.

Tenacity of Life of an Eel.

I HAVE lately had occasion to notice a further proof of the tenacity of life exhibited by the eel, which may perhaps be of interest.

A correspondent in America, Mr. L. L. Mowbray, of the Aquarium, Battery Park, New York City, has kindly sent me from time to time specimens of elvers[1] of the American eel, preserved in formol, for investigation purposes. Quite recently, a parcel from Mr. Mowbray was delivered at the laboratory here. Greatly to our surprise, however, instead of elvers preserved in formol as usual, it proved to contain a single specimen very much alive.

The little eel was enclosed in a small glass bottle (quarter-litre size), which had been corked and waxed so as to render it perfectly air-tight, and the bottle again enclosed in one of the tin cylinders commonly used in the United States for sending natural history specimens by post. The tiny creature had thus made its voyage across the Atlantic in complete darkness, and without any renewal of air in the 200 c.c. of water in which it was originally placed.

The postmarks showed that it had left New York on April 19, and arrived in Copenhagen on May 19, 1923. It has now been transferred to a small aquarium, where it is still alive and active, to all appearances in excellent form after its lengthy journey.

Evidently, then, the American fresh-water eel is by no means inferior to its European cousin in respect of endurance and tenacity of life.

I may add that we have, at the Laboratory here, two live adult specimens of the American eel. They have been in our aquaria since 1914, when we brought them home, as elvers, from Santa Cruz, in the West Indies. They, however, made the journey in an open beer bottle, with frequent changes of water, and were thus not subjected to so severe a test of endurance as the specimen above mentioned.

JOHS. SCHMIDT.

Carlsberg Laboratory, Copenhagen,
June 28.

[1] The youngest stages of eel-fry which make their way up into fresh water are called elvers.

Adsorption on Soil-Grains.

THE recently published work by Messrs. J. Hendrick and G. Newlands (*Journ. Agric. Sci.*, January 1923) on the mineral particles in the coarser grades of the "fine earth" separated from soils was noticed in NATURE of June 9, p. 736, and it was remarked that "the study of adsorptive reactions should not be entirely restricted to the colloidal field."

It is of interest to note that the United States Department of Agriculture took up this question last year, and its Bulletin No. 1122 (October 21, 1922) records the work of Messrs. M. S. Anderson, W. H. Fry, P. L. Gile, H. E. Middleton, and W. O. Robinson, on "Absorption by colloidal and non-colloidal soil constituents." The authors worked on material finer than 2 mm. in diameter, which, in common with so many experimenters, they call "the soil," by an unfortunate restriction of the term. This earth is separated, preferably by centrifugal methods, into three grades, 2·000–0·050 mm., 0·050–0·001 mm., and less than 0·001 mm., the last being styled colloidal. In testing the relative powers of adsorption on (or absorption by) these grades, it was justly felt that samples really free from colloidal matter could be best obtained by crushing unaltered minerals. In

each case, the grade 0·050–0·001 mm. was selected and examined under the microscope, the particles being counted and measured; the surface exposed by samples weighing one gram was thus determined for a number of common minerals.

The conditions of comminution seem, however, not quite comparable with those in natural soil-material, where it may be doubted if quartz and garnet, for example, present so large a surface in comparison with other minerals as appears from the table on p. 9. Limonite, again, is probably distributed in soils in a much finer form than is suggested by the artificially crushed material. Where a mineral grain, again, goes to pieces mainly under chemical action, as in the case of olivine set free from basalt, it may yield surviving cores that are of considerable coarseness. The table referred to, however, has obviously very great interest in connexion with the work of Hendrick and Newlands on the mineral constitution of various grades in a fine earth.

The American absorption-tests have been made with a dye (malachite green), water vapour, and ammonia, according to methods that are carefully stated. Four typical samples from the U.S. soil-series were then treated, and it was found that the absorption by the "non-colloidal minerals" (I should prefer to write "non-colloidal mineral particles") is less than 2 per cent. of the total absorption by the fine earths used. It is pointed out that this result is affected to some extent by the wide range of absorptive power shown by the tests on separate minerals. Reference is made to W. O. Robinson's work on "The inorganic composition of some important American soils" (U.S. Depart. Agric. Bulletin 122, 1914), in which the average constitution of the "silt" group in 26 soils was determined as quartz 51, potash felspars 7, muscovite 7, and other minerals 35 per cent. The dye-absorption is practically nothing for quartz and orthoclase; but the authors of Bulletin 1122 state that in a soil rich in muscovite the absorption by non-colloidal particles may be as high as 7 to 20 per cent. of the total absorption of the fine earth.

The conclusion is that the particles styled colloidal possess absorptive characters that are dependent on their composition and not merely on their fineness of comminution. The authors confirmed this opinion by grinding six selected minerals dry in a steel ball mill to a fineness of 1 micron and less, so as to reduce them to the "colloidal" grade. The coarser particles were then (p. 14) removed by sedimentation extending over several days. The average value for absorption of ammonia by these finely powdered minerals is only 22 per cent. of that given by the "ultra clays" from a number of different soils. The fine quartz and microcline showed practically no absorption for malachite green; but chlorite and muscovite gave results equal to the lowest of those obtained from the colloidal particles in the 33 soils tested. It is pointed out that some alteration may have taken place in the powdered minerals by hydrolysis during the process of separation. Their absorptive power may have been thus increased, and may be in part due to the formation of gels upon the particles. Experiments were then made with synthetic gels, and it now seems highly probable that by far the greater part of absorption in the fine earth of soils is due to gels in the material finer than 1 micron in diameter. The term "colloidal" thus comes to have a more definite significance when applied to the constituents of a soil.

GRENVILLE A. J. COLE.

Geological Survey of Ireland,
Dublin, July 12.

Discovery of Ascodipteron in Ceylon.

HITHERTO the species of this peculiar genus of Streblidae have been known only from the Malayan sub-region. Thanks to the interest taken on my behalf by Mr. W. W. A. Phillips of St. George Estate, Matugama, well known locally as an authority on the Chiroptera, I have to announce the discovery of an encysted female of the genus in the small leaf-nosed bat of Ceylon, *Hipposideros atratus*. The specimen was attached to the skin in the vicinity of the tail, whereas previously discovered specimens have been found either in the wing membrane (Adensamer) or at the base of the ear (Muir). The host, also, is of a species in which these parasites have not been hitherto recorded, and Mr. Phillips informs me that it is usually very free from all such, a character which it shares with the rest of its family.

The identity of the specimen has been confirmed by Mrs. Q. Cattell Kessell, working with Dr. Scott at Cambridge.

RONALD SENIOR-WHITE.

The Kepitigalla Rubber Estates, Ltd.,
Suduganga Estate, Matale,
Ceylon, June 1.

ASCODIPTERON is one of the most remarkable examples of specialisation to a parasitic existence known among insects. It was described by Adensamer in 1896 from a single example found imbedded in the dorsal wing-membrane of a bat (*Phyllorhina* sp.) from the Dutch East Indies. Subsequently Mr. Frederick Muir found a number of examples of another species, imbedded in the skin at the base of the ear, on seventeen specimens of *Miniopterus schreibersi* taken at Amboina; from these he obtained puparia and bred both sexes of the fly, publishing an account of the life-history (1912) and referring the insect to the family Streblidæ.

The newly emerged males and females have fully developed wings and legs. At a later stage the female bores its way into the skin of the bat by the aid of a series of remarkable cutting blades on its proboscis, loses its wings and legs almost entirely (only the stumps being present in the fully imbedded individual), and becomes almost completely encysted under the skin of the host, only the posterior extremity of the abdomen remaining external. The front part of the abdomen becomes enlarged and completely engulfs the head and thorax, which come to lie, as though invaginated, at the bottom of a pit. The imbedded female gives birth to a full-fed larva, which falls to the ground and immediately pupates, as is normal in "pupiparous" Diptera.

The discovery of specimens, which may possibly represent a new species of the genus, in Ceylon is highly interesting.

HUGH SCOTT.

University Museum of Zoology,
Cambridge, July 11.

Antarctic Geophysics.

HAVING been responsible for the final values of g derived from the pendulum observations made in the Antarctic in 1902–3 by Commander Bernacchi and his associate Engineer-Commander Skelton, I wish to direct attention to a point which has apparently escaped your reviewer when making the following statements (NATURE, vol. 111, p. 898): "The mean value of g from the three pendulums used in

1912 [by Capt. C. S. Wright] at Cape Evans was 983·003 from the July series and 983·004 from the August series. . . . Commander Bernacchi . . . obtained the values 982·970, 982·979, and 983·025. . . . These values may be compared with the standard value 981·292 at Potsdam. . . ."

This suggests the existence of a substantial difference between the results of the two British expeditions. This does not, however, seem to be the case. The final value for *g* derived from Commander Bernacchi's observations (National Antarctic Expedition 1901–1904, "Physical Observations," Table V., p. 34) was 982·985. In obtaining this, for reasons stated in the discussion, half weight only was allowed to the third pendulum. Thus the *apparent* difference between the results from the two expeditions is $0{\cdot}018_5$ cm./sec.^{2}. But this is accounted for by the fact that while Capt. Wright accepted for *g* at Potsdam—on which all the Antarctic results really depend—the value 981·292 quoted by your reviewer, I accepted 981·274 on the authority of Sir Gerald Lenox-Conyngham (Roy. Soc. Proc. A, vol. 78, p. 245). The difference between these two assumed values is 0·018 cm./sec.^{2}. Thus the values obtained by the two Antarctic expeditions—not exactly at the same place—really agreed to six significant figures. Though not assigning the importance that Paley did to "undesigned coincidences," I think this coincidence is remarkable enough to be worth mentioning. It would be of interest in this connexion to know what value the German experts assign now to *g* at Potsdam. C. CHREE.

June 30.

The Translocation of Carbohydrates in the Sugar Maple.

THE conclusion of Prof. H. H. Dixon (NATURE, February 23, 1922, p. 236, and October 21, 1922, p. 547) that the translocation of organic substances could take place through the vessels of the xylem appears to have created a mild sensation among plant physiologists. Attention, however, does not seem to have been directed to the behaviour of the sugar maple, which furnishes important evidence in this connexion.

The sugar maple or rock maple (*Acer saccharum*, Marsh) is well known in Eastern Canada and New England as the source of the maple syrup and maple sugar of commerce. To obtain the sap, a small hole about half an inch in diameter is bored into the sapwood to a depth of about 3 inches, at a height of about 4 feet above the ground-level at the time when the snow is melting at the beginning of spring. A metal tube is inserted into the hole, and a small bucket is attached into which the sap drops from the metal spout. The sap as it oozes from the tree is colourless, but becomes brown on concentration by boiling.

A bulletin entitled "The Maple Sap Flow," by Jones, Edson, and Morse, published by the Vermont Agricultural Experiment Station in 1903, gives a full account of observations and experiments on this subject. Some of the conclusions reached by these investigators are as follows: The sap contains about 3 per cent. of sucrose and also small amounts of proteids, mineral matter, and acids, mainly malic acid. The greatest sap flow does not occur at the time when the most water is contained in the tree. More sap flowed at the opening of the sugar season than at the close when more water was in the tissues. There is no evidence that the water is forced into the maple trunk by root pressure at any season. Warm sunny days and freezing nights form ideal sugar weather. On good sap days the pressure from above downwards is greater than that from below upwards. The flow generally, but not always, parallels the pressure. Later in the season and upon poor sap days, upward pressure and flow exceed those from above. The fastest run of sap from a tap hole during the experiments was 17·7 c.c. per minute. Jones and Orton, using lithium chloride, had previously determined the rate of flow in either direction as 2 to 6 inches per minute.

Some observations on this subject were made during the spring on two trees, numbered respectively 185 and 3389, growing in the Botanical Garden at Ottawa. In order to determine whether the flow of sap came from the bark or the wood, several small branches on each tree were chosen which projected horizontally or inclined slightly upward. These were cut across at right angles to their length on March 1, 1923, the cut end was smoothed and the bark peeled off close to the wood for a distance of about an inch from the cut end. In tree No. 185 sap commenced to flow on April 11 and ceased on April 27, while in tree No. 3389 the respective dates were April 17 and May 14. In no instance was sap observed to exude from the cut surface of the bark. Several observations were made on the rate of flow of sap from a cut branch together with records of temperature, etc. In tree No. 185 a branch measuring 15 mm. in diameter (including the bark) was selected, while in tree No. 3389 the diameter of the branch was 18 mm. The number of drops falling per minute was counted; the diameter of each drop was about 5 mm. Some of the results were as follows:

April 19, 1923. Tree No. 185. Time, 3.40 P.M. Shade temperature = 50° F. Fifty-one drops fell in five minutes.

April 20, 1923. Tree No. 185. Time, 3.15 P.M. Shade temperature = 77° F. Sunny. Two counts gave 8 drops each per minute.

April 16, 1923. Tree No. 3389. Time, 3 P.M. Shade temperature = 38° F. Snow was still lying round the base of the tree. Sap was flowing at the rate of 18 drops in five minutes. Another count gave 17 drops in five minutes.

April 19, 1923. Tree No. 3389. Time, 3.55 P.M. Shade temperature = 50° F. Some snow still around the base of the tree. Drops were falling at the rate of 115 in five minutes. Another count gave 22 drops in one minute.

A microscopical examination of twigs cut from each tree on March 1 and on May 7, on which date the buds were swelling, showed abundant starch grains in the medullary rays but none in the pith on both occasions. The amount of water present in several small branches half an inch in diameter taken from each tree was also determined for the above dates, when it was found that each tree contained 1 per cent. less water on May 7 than it did on March 1.

The spring flow of sap was also observed in five other species of maple growing in the Botanical Garden here. In *Acer Myabei* on April 14 an icicle measuring 9 inches long and $1\frac{3}{4}$ inches wide at the base was observed hanging from a broken branch.

While some points in the metabolism of the maple sap may still be obscure, it is abundantly evident that the vessels of the wood are able to carry the sugar solution in both directions in the tree-trunk and that the rate of flow is comparatively rapid.

J. ADAMS.

Central Experimental Farm, Ottawa,
July 11.

The Origins of the Conception of Isotopes.[1]

By Prof. FREDERICK SODDY, F.R.S.

ONE of the most important consequences of the study of the chemistry of the products of radioactive change has been the discovery of isotopes and the interpretation, in consequence, of the Periodic Law in terms of modern views of atomic structure. It is one of the few fields in the vast borderland between physics and chemistry, overrun of recent years by an advancing swarm of mathematicians and physicists, armed with all sorts of new-fangled weapons, in which the invaders have found the chemist already in possession. The broad highways they have hewn thereto are already dusty with the feet of pilgrims and are being watered by the tears of candidates for "Honours." But the somewhat intricate bye-ways through which the chemist first found his way into this virgin territory, and the views on the road before it was in sight, may still preserve something of their pristine interest.

The word *isotope* signifies "the same place," in allusion to isotopes occupying the same place in the Periodic Table. Before this word of theoretical meaning was coined, isotopes were experimentally well known as elements non-separable by chemical methods and completely identical in their whole chemical character. The analysis of the constituents of matter, to which we were born and brought up to regard as the most searching and fundamental, is an analysis by means of its chemical properties. Although, later, a new and even more powerful method—spectroscopic analysis—was developed, it merely dotted the *i*'s and crossed the *t*'s of chemical analysis, filled in a few vacant places in the Periodic Law, and handed over the newcomers to the chemist to classify along with the rest of the eighty or so "foundation stones" of which he supposed the material universe to be built up.

With the close of last century another new method—radioactive analysis—was developed, which is applicable, of course, only to the radio-elements; that is, to the elements uranium and thorium and the 34, as we now know, successive unstable products of their spontaneous disintegration. Each of these possesses a definite radioactive character; it is produced from one and changes into another element, and, in both changes, rays characteristic of the two substances are expelled, which are as fine a hall-mark of their identity as any of the "tests" of chemical analysis. But radioactive character, unlike spectroscopic character, is completely independent of chemical character. The latter might be called "existence properties," whereas the radioactive character is that attending the explosion of the atom which terminates the existence of the element as such. It provided the necessary independent method of analysis capable, for the first time, of distinguishing between elements identical chemically and occupying the same place in the Periodic Table, *i.e.* between isotopes.

THE EARLIER CHAPTER OF RADIO-CHEMISTRY.

Not a hint of this, however, was afforded by the earlier chapter of radio-chemistry. On the contrary, no development could appear more normal. Just as rubidium, thallium, etc., were detected by the spectroscope before anything of their chemistry was known, so radium was detected in pitchblende by its radioactivity in concentration thousands of times less than is necessary to show a single line of its spectrum. But with more concentrated preparations a new spectrum *was* discovered, and then a new element, which was found to possess a chemical character entirely new and sufficing for its separation in the pure state from all other elements. As in the case of the elements discovered by the spectroscope, radium was found to occupy a place, hitherto vacant, in the Periodic Table. But, as it happened, radium is exceptional in this. Its chemical character was quite normal, and indeed could have been largely predicted beforehand for the missing element occupying this place. The development of the subject showed it to be but one of some 34 radio-elements formed from uranium and thorium. But there are not 34 vacant places in the Periodic Table to accommodate them.

META-ELEMENTS.

So far as I am aware, there is no anticipation, prior to the systematic study of the chemistry of the radio-elements, of the idea that there may exist different elements with absolutely identical chemical character. Sir William Crookes, it is true, once thought, though the idea has not survived more extended examination, that the properties of the elements, as we know them, might be a mean value, and that the individual atoms composing the element might differ in weight and chemical character continuously on either side of this mean. If so, more refined methods might serve to resolve the element into a collection of what he termed "Meta-elements," possessing the main character of the original, but differing from one another to a slight extent. Misled by the phosphorescence spectra, which are now known to be characteristic of mixtures rather than chemically homogeneous substances, he thought at one time that he had been successful in so resolving yttrium. But the present idea, that elements may exist absolutely the same in chemical nature and yet absolutely different in other properties, such as radioactivity and atomic weight, is totally distinct from this.

THE EXPERIMENTAL METHOD THAT FIRST REVEALED ISOTOPES.

I venture to think that no more elegant extension of our methods of gaining new knowledge has ever been obtained than that which, in due course, was to reveal the existence of isotopes. The original observations, upon which the theory of atomic disintegration was first founded, were that thorium is continuously producing a new radioactive substance, thorium X, separable from it by precipitation with ammonia but not with other precipitants, and, after separation, continuously re-forming again. The thorium X was short-lived and changed again into a gas, the thorium emanation, for which the name *thoron* has recently been proposed, which was even shorter-lived and changed again to a solid—the "excited activity" now known

[1] Discourse delivered at the Royal Institution on Friday, May 4.

as the active deposit—which again went through further changes. The rays resulted from these successive changes, α-rays in the first and α-, β-, and γ-rays in the last changes. Below is the first part of the thorium disintegration series as it appeared to Sir Ernest Rutherford and myself in 1903:

$$\text{THORIUM} \xrightarrow{\alpha} \text{THORIUM X} \xrightarrow{\alpha} \text{THORON} \xrightarrow{\alpha}, \text{etc.}$$

In 1905 Sir William Ramsay and O. Hahn were engaged in extracting radium from thorianite, a new Ceylon mineral containing both uranium and thorium in important quantity. The radium was separated with the barium, and the chlorides fractionated in the usual way. They found a new radio-element to be present and to be separated from the radium with the barium. It proved to be the direct parent of thorium X, and intermediate in the series between the latter and thorium, and they called it radiothorium. In spite of this easy and apparently straightforward separation, the experience of a number of chemists showed that something remained to be explained, for it was found to be difficult to the verge of impossibility to separate radiothorium from thorium. Ramsay and Hahn had in fact "separated" isotopes in 1905, for radiothorium and thorium are isotopes. Yet further work has shown the two to be so alike that no separation by chemical means is possible!

Then in 1907, along with the radium which had been separated from thorianite, Hahn discovered another new radio-element, mesothorium, the direct parent of radiothorium and intermediate between it and thorium. In the next year he showed that mesothorium consists of two successive products—the first, the direct product of thorium, mesothorium 1, being practically rayless and generating a short-lived product, mesothorium 2, giving powerful β- and γ-rays.

This resolved the mystery, and one cannot do better than to quote the words of McCoy and Ross (J. Amer. Chem. Soc., 1907, 29, 1709).

> "Our experiments strongly indicate that radiothorium is entirely inseparable from thorium by chemical processes. . . . The isolation of radiothorium from thorianite and from pure thorium nitrate . . . may have been accomplished by the separation of mesothorium which in time changed spontaneously into radiothorium."

Thus the radiothorium separated from the mineral thorianite by Ramsay and Hahn was not the radiothorium *in the mineral*, but that subsequently produced from the easily separated mesothorium, after it had been removed from the thorium. If they had fractionated the radium-mesothorium-barium mixture at once they would not have discovered radiothorium. The lapse of time after the separation of the mesothorium is essential. Nowadays many non-separable radio-elements are, like radiothorium, "grown" from their separable parents. Thus radium D, an isotope of lead, is grown from the radium emanation (radon), although it cannot be separated from the mineral, which always contains lead in quantity.

The first part of the thorium series now runs [2]

$$\underset{2\cdot10^{10}\text{ years}}{\text{THORIUM}} \xrightarrow{\alpha} \underset{9\cdot67\text{ years}}{\text{MESOTHORIUM 1}} \longrightarrow \underset{8\cdot9\text{ hours}}{\text{MESOTHORIUM 2}}$$

$$\xrightarrow{\beta} \underset{2\cdot91\text{ years}}{\text{RADIOTHORIUM}} \xrightarrow{\alpha} \underset{5\cdot25\text{ days}}{\text{THORIUM X}} \xrightarrow{\alpha} \underset{78\text{ seconds}}{\text{THORON}} \xrightarrow{\alpha}, \text{etc.}$$

In this series thorium and radiothorium and mesothorium and thorium X are two pairs of isotopes. If we represent the successive products by balls of different colours to indicate their chemical character, isotopes being of the same colour, chemical analysis will sort the balls into their different colours, and the lapse of time will cause some of the colours to change. The ball representing mesothorium will in time turn into that representing radiothorium, so that the latter, before indistinguishable from thorium, becomes known as a separate individual.

The Isotopes of Uranium.

It will be noted that the method of separating isotopes depends upon their being alternate rather than successive in the series. If radiothorium had been the direct product of thorium, the two would to this day never have been separated. The changes of chemical character are, as we shall later see, intimately connected with the electric charges on the α- and β-particles expelled. For successive products to have the same character, no rays, or at least no charged particles, must be expelled. It is always as well, and no subject illustrates the point better than that of isotopes, to reflect not only upon what our methods are able to reveal but also upon what they could not reveal.

At first it seemed that uranium itself was a case of successive isotopes. Boltwood in 1908 proved from his study of the relative activities of the successive products giving α-rays in minerals, that whereas all of them, except uranium, gave off only one α-particle per atom disintegrating, uranium gave off two. By direct observation with the scintillation method it was proved that the two α-particles from uranium are *not* simultaneously expelled, and later it was shown that they possess different velocities. If the slower comes from uranium itself (uranium I), the period of which is known to be $6\cdot10^9$ years, the swifter must come from the isotope (uranium II), and its period must be some three million years. This is an example of isotopes being revealed by difference of radioactive nature simply, though no other evidence of their separate existences is available. Owing to the long periods of the α-ray-giving members of the early part of the uranium series, it has been much more difficult to unravel than the thorium series. As a result of researches too numerous to detail, it has been concluded that the main series is almost entirely analogous to the thorium series and runs

$$\underset{6\cdot10^{9}\text{ years}}{\text{URANIUM I}} \xrightarrow{\alpha} \underset{35\cdot5\text{ days}}{\text{URANIUM X}_1} \xrightarrow{\beta} \underset{1\cdot65\text{ minutes}}{\text{URANIUM X}_2} \xrightarrow{\beta} \underset{3\cdot10^{6}\text{ years}}{\text{URANIUM II}}$$

$$\xrightarrow{\alpha} \underset{10^{5}\text{ years}}{\text{IONIUM}} \xrightarrow{\alpha} \underset{2\cdot440\text{ years}}{\text{RADIUM}} \xrightarrow{\alpha} \underset{5\cdot55\text{ days.}}{\text{RADON}} \xrightarrow{\alpha}, \text{etc.}$$

Though two short-lived products probably intervene between the two uraniums, analogous to the two mesothoriums between thorium and radiothorium, the relation of their period to that of their product, uranium II, is so hopelessly unfavourable that there is no hope of ever being able to put the separate existence of uranium II into evidence in the same way as was done

[2] The periods shown in the second line are the periods of average life of the successive products. These are 1·443 times the period required for one-half of the element to change.

for radiothorium. For all *practical* purposes the two uranium are as non-separable by this method as if they were actually successive products. I spent many years, before this part of the series was at all well known, looking for the product of uranium X, and separated this constituent from 50 kilograms of uranium nitrate repeatedly in the attempt. I was looking for a growth of α-rays concomitantly with the decay of the β-rays of the uranium X. If the product had been ionium, as at first thought $(\mathrm{UI}\xrightarrow{\alpha}\mathrm{UII}\xrightarrow{\alpha}\mathrm{UX}\xrightarrow{\beta}\mathrm{Io}\xrightarrow{\alpha})$, it should have been just possible to detect it; but since it is the 30 times longer-lived uranium II, the attempt is hopeless, especially as uranium X and ionium are isotopes, and therefore the uranium X separated must always possess a certain initial α-activity due to ionium.

THE ABSOLUTE CHEMICAL IDENTITY OF ISOTOPES AND ITS IMPLICATIONS.

The years 1908–10 were productive of many prolonged and serious efforts to separate isotopes by chemical means. In 1908 Boltwood discovered ionium and showed that it resembled thorium. Keetman, who with Marckwald discovered ionium independently, tried twelve good methods all known to be effective in the purification of thorium in the attempt to separate the ionium from thorium, completely without success. Auer von Welsbach, on a technical scale, separated the ionium and thorium from 30 tons of pitchblende and tried fresh methods in the hope of separating them, but failed. It was with this preparation that Exner and Haschek tried without success to find the ionium spectrum; and Russell and Rossi confirmed their result, that the spectrum of ionium was that of pure thorium. When later I had determined beyond doubt, from measurements of the rate of growth of radium from uranium, that the period of ionium was 100,000 years, and that Welsbach's preparation must have been approximately 30 per cent. ionium and 70 per cent. thorium by weight, it followed that the spectra of isotopes must, like their chemical character, also be identical. The difference, if any exists, is almost beyond the limit of detection by the most powerful methods.

Similarly, the chemical identity of radium D and lead was established as a consequence of very prolonged and refined chemical examination. Paneth and Hevesy established upon this their well-known method of using radioactive isotopes as indicators for elements in too small quantity to be dealt with except by such methods. On the principle that wherever the radioactive element is there will its inactive isotope be also, provided that they have once been properly mixed, many difficult or uncertain chemical analyses may be converted into simple radioactive ones.

In 1909 Strömholm and Svedberg made what was probably the first attempt to fit a part of the disintegration series into the Periodic Table, and although the effort in itself was in an important respect erroneous, in their paper is to be found the first anticipation that the chemical non-separability found for certain pairs and groups of radio-elements may also apply to the non-radioactive elements. Remarking on the fact that there are three parallel and independent radioactive series, they suppose this to proceed down through the Periodic Table, "but that always the three elements of the different genetic series, which thus together occupy one place in the Periodic System, are so alike that they always occur together and also have not been able to be appreciably separated in the laboratory." They point out also, this idea would explain the exceptions to the Periodic System "if the elements of the scheme were mixtures of several homogeneous elements of similar but not completely identical atomic weight."

In the next year I arrived independently, and without in the least postulating any continuance of the genetic series beyond the radio-elements, at a similar view. Marckwald and I found independently that mesothorium 1 was chemically similar to radium, a fact undoubtedly known to Hahn and those engaged in the technical extraction of mesothorium, but kept secret. It was known from some work of Boltwood that precipitating barium sulphate in a solution containing mesothorium removes it, but it was thought that the action of the barium sulphate was similar to that in removing uranium X, for which it had long been used, namely, a simple adsorption. I was surprised to find it absolutely different. The removal of the barium from the mesothorium, as from radium, could only be accomplished by the fractional crystallisation of the chlorides. In this fractionation the radium and mesothorium remained together and behaved as a single element. Within the limit of error of the most careful radioactive measurements, there was no change in the relative proportion of the two elements at the end of the process from that in which they exist in the original mineral.

Chemistry has many cases of elements similar in chemical character, but nothing approaching this. For we know, beforehand, that we are dealing with a mixture of two substances and can estimate accurately the proportion of each individual. Yet to all chemical operations they behave as a single substance. The differences of atomic weight are considerable, two units in the cases of mesothorium and radium, and of ionium and thorium, and four units in that of radiothorium and thorium. It was certain that if isotopes existed in the case of the ordinary chemical elements the absence of a second radioactive nature independent of the chemical nature would make it impossible for them to have been recognised. Hence the implication followed that any supposed element may be a mixture of several chemical identities of different atomic weight, and any atomic weight might be merely a mean number (Ann. Reports, Chem. Soc., 1910, 286). There is an element of tragedy in this. The lifetime labours of the chemists who, since the time of Stas, have devoted themselves to the exact determination of atomic weights appear to have as little theoretical interest now as if you sought to determine the average weight of a collection of beer bottles, all exactly alike but not all quite full.

THE RADIO-ELEMENTS AND THE PERIODIC LAW.

The years from 1911–13 were crowded with important advances, and to do the exact history justice would take an undue share of the available time. In 1911 the chemistry of most of the α-ray-giving members was sufficiently known for it to be seen

that the expulsion of the α-particle caused the element expelling it to move from the place it occupied in the Periodic Table to the next place but one to it in the direction of diminishing mass.

At this time the chemistry of the post-emanation members had scarcely been studied, though von Lerch, from electrochemical researches, had put forward the rule that the successive products are each electrochemically "nobler" than the last, a rule which describes well enough the electrochemical behaviour of the first three—the A to C members, as they are called. Then, as a result of the experiments of Schrader and Russell, it was found that their volatility was much affected by chemical treatment and by the atmosphere in which they were volatilised. Thus, in hydrogen, radium C volatilises at as low a temperature as 360° C., though, in air, a temperature of 1200° is necessary. This clearly indicated the possibility that even these excessively ephemeral elements have a definite chemical character. Hevesy showed, by electrochemical methods, that the three B-members are identical in properties among themselves, and also the three C-members.

But the work which, more than anything else, served to reveal, as in a flash, the simple and sweeping generalisation which covers the evolution of the radioactive elements was that of A. Fleck in my laboratory in Glasgow. He studied the chemistry of the various members, still uncharacterised, from the definite point of view of ascertaining to which element each most closely approximated in chemical character, and then whether it was separable from that element or not. In addition to confirming more rigorously many conclusions already reached, he proved that mesothorium 2 was non-separable from actinium, the three B-members from lead, like radium D, and the three C-members and radium E from bismuth.

Hevesy and Russell—the first with regard to the valency of the radio-elements and the second with regard to the positions they occupy in the Periodic Table—published early in 1913 statements of the full law underlying radioactive evolution, but only in part correct. Within a month K. Fajans, in Carlsruhe, published the scheme correct and complete, including the complicated branchings that occur at the C-members. In a paper, amplifying and amending Russell's scheme, I arrived independently at the same scheme as Fajans. Each α-ray expelled causes a shift of two places in the Periodic Table in the direction of diminishing mass, and each β-ray a shift of one place in the opposite direction. In its present form the scheme is shown in Fig. 1. The chief uncertainty remaining is whether the actinium branch starts from uranium II, as shown in the figure for convenience, or from uranium I, or even from a third independent isotope of uranium. So that the atomic weights shown for the actinium series are purely provisional.

By the consistent application of the two rules mentioned, the members found to be non-separable from one another fall in the same place in the Periodic Table. The chemical character has nothing to do with the radioactivity, nor with the series to which the element belongs, nor with its atomic weight. It depends upon a number, now called the atomic number, shown at the top of the place in the figure.

Before passing on to this, the chief practical consequences of the generalisation may be briefly enumerated.

(1) Of the members still uncharacterised, the A and C′ members must be the isotopes of polonium (radium F) and radium C_2 (now called radium C″), actinium D and thorium D must be isotopes of thallium. Fleck at once verified these predictions as regards radium A, actinium D, and thorium D.

(2) Uranium X, like mesothorium, must consist of two successive β-ray-giving products, intermediate between the two uraniums. Fajans and Gohring at once succeeded in separating from uranium X a very short-lived product, uranium X_2, giving the more penetrating of the two types of β-ray expelled, the uranium X_1 giving the less penetrating β-rays.

(3) The parent of actinium in the IIIrd family must be an isotope of radium, if actinium is formed in a β-ray change—a conclusion I at once experimentally disproved—*or* it must be an isotope of uranium X_2, in the Vth family, if actinium is formed in an α-ray change. This was proved by Cranston and myself, and the name "eka-tantalum" given to the new element, and by Hahn and Meitner, who named it protoactinium. It is linked to uranium through uranium Y, a branch member discovered by Antonoff in 1911, and suspected to be in the actinium series.

Protoactinium, to give it Hahn and Meitner's name, has been shown by them to give α-rays and to be chemically so like tantalum that hitherto it has not been separated from it. Its period is about 17,000 years, and from this it may be calculated that there is about one-fifth as much of it by weight in minerals as there is of radium. This may be sufficient to enable it to be isolated, and for its spectrum, atomic weight, and chemical character to be ascertained. The branch series runs

$$\underset{\mathrm{VI}}{\mathrm{U}} \xrightarrow{\alpha} \underset{\mathrm{IV}}{\mathrm{UY}} \xrightarrow{\beta} \underset{\mathrm{V}}{\mathrm{Pa}} \xrightarrow{\alpha} \underset{\mathrm{III}}{\mathrm{Ac}} \longrightarrow \underset{\mathrm{IV}}{\mathrm{RaAc}} \xrightarrow{\alpha} \underset{\mathrm{II}}{\mathrm{AcX}} \xrightarrow{\alpha} \underset{0}{\mathrm{An}} \xrightarrow{\alpha}, \text{ etc.}$$

in which the figures in the second line refer to the family in the Periodic Table to which the element belongs.

(4) All the ultimate products in all branches are isotopes of lead. The atomic weight of the two products of thorium are both 208, and of the major branch of uranium 206. As is well known, this had only to be tested to be proved correct. The atomic weight of the lead from the purest thorium minerals is as high as 207·9, and of that from the purest uranium minerals 206·0. The spectra of these isotopes, but for the infinitesimal difference already alluded to, are identical. But the densities are proportional to their atomic weights. This was a very simple prediction I made, before testing it, from the theoretical views about to be dealt with.

The Theoretical Interpretation of Isotopes.

The results on the theoretical side were no less definite and important, and isotopes found a ready explanation on the nuclear theory of atomic structure put forward in a tentative form by Rutherford in 1911. This theory accounted for the large angles through which occasional α-particles were deflected in their

passage through atoms, by the existence of a very minute highly charged nucleus at the centre of the atom, the rest of the atom being occupied by separate charges of opposite sign equal in number to the nuclear charge. For such an atom scattering should be proportional to the square of the nuclear charge. Experiment showed that scattering was approximately proportional to the square of the atomic weight. So that it looked as if, as in the α-particle itself, there existed one unit of nuclear charge to each two units of atomic weight. This would make the nuclear charge of uranium of atomic weight about 240, 120+.

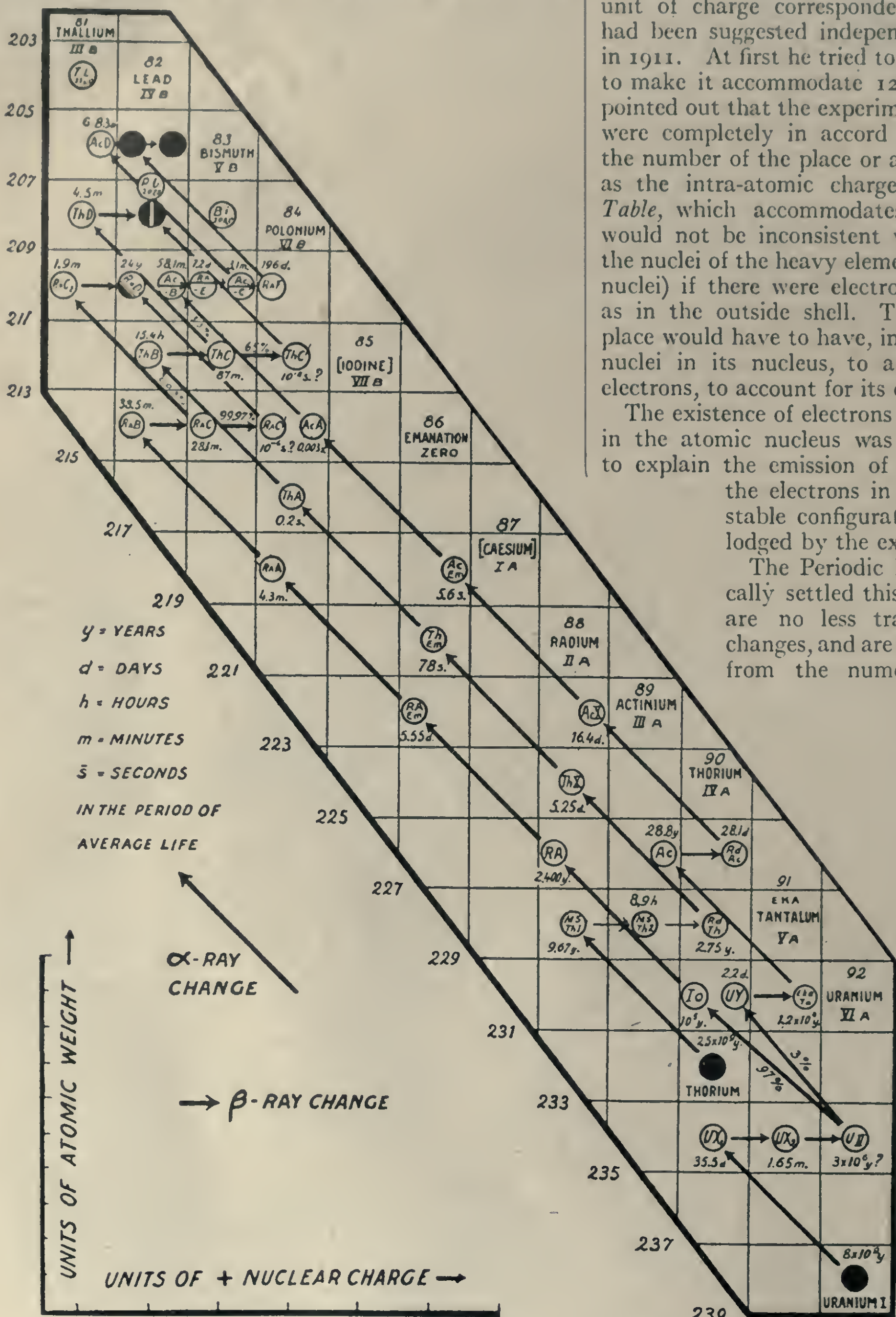


FIG. 1.—Radio-elements and the periodic law. All elements in the same vertical column are isotopes.

Since the α-particle carries two positive charges and the β-particle one negative, the obvious inference from the figure is that the successive places in the Periodic Table correspond with unit difference in the intra-atomic charge. This view, and also that each unit of charge corresponded to two units of mass, had been suggested independently by van der Broek in 1911. At first he tried to stretch the Periodic Table to make it accommodate 120 places. But in 1913 he pointed out that the experimental results for scattering were completely in accord with his own view (that the number of the place or atomic number is the same as the intra-atomic charge) *on the existing Periodic Table*, which accommodates some 90 elements. It would not be inconsistent with his other view (that the nuclei of the heavy elements are made up of helium nuclei) if there were electrons in the nucleus as well as in the outside shell. Thus uranium in the 90th place would have to have, in addition to the 60 helium nuclei in its nucleus, to account for its weight, 30 electrons, to account for its charge of 90+.

The existence of electrons as well as positive charges in the atomic nucleus was also postulated by Bohr to explain the emission of β-rays, for on his theory the electrons in the external shell form a stable configuration and could only be dislodged by the expenditure of work.

The Periodic Law generalisation practically settled this question. β-ray changes are no less transmutational than α-ray changes, and are sharply to be distinguished from the numerous processes, such as friction, chemical change, action of ultra-violet light, and incandescence, during which electrons are detached from atoms. The effect on the chemical character produced by the expulsion of one α-particle is exactly undone by the expulsion of two β-particles, and the product becomes isotopic with the original parent. This means that both α- and β-particles must be expelled from the nucleus and that isotopes are elements the atoms of which have the same *nett* nuclear charge; *i.e.* the same excess number of positive over negative charges in the nucleus, but different numbers of positives and negatives reckoned separately. For such systems the electronic shell would be identical, and so the identity of the chemical and spectroscopic character is explained. Also the atomic volume is the same; that is, the density must be proportional to the atomic weight.

We were able to get an interesting confirmation of this view. In the change of uranium X_1 to uranium II

two electrons are lost as β-rays. In the oxidation of a uranous salt to a uranic or uranyl salt two electrons are also lost,

$$U^{++++} = U^{++++++} + 2E.$$

If these come from the same region of the atom as the β-particles, then uranous salts, so long as their valency does not change, should be like uranium X_1, chemically non-separable from thorium. Fleck, trying this, found great similarity in chemical properties between uranous salts and thorium, but not identity. He was able to separate them by chemical methods without changing the valency of the uranous salt.

The great merit of the nuclear atom from the chemist's point of view was that it afforded for the first time a clear picture of the difference between a chemical and a transmutational (or radioactive) change. The latter occur in the nucleus and are irreversible. The external shell accommodates itself instantly to the change of the nucleus. But any change suffered by the external shell (chemical change) has no effect on the nucleus, which always acts so as to make the external shell conform to one most stable configuration.

The atom is an *imperium in imperio*, and like most such systems is very conservative and resistant to change. The electrons in the shell, that govern almost all the atomic properties, except mass and radio-activity, are in turn but the bureaucratic instruments of the real government, which is the intensely charged central nucleus. The transmutation of atoms, as of social systems, is alike impossible because the apparent government is not the real government. Rutherford's experiments on the bombardment of atoms by α-particles show that only about one out of a hundred thousand of the latter, in passing through hydrogen, ever hits a hydrogen nucleus, and the proportion of hits to misses is something like one in a thousand millions. In politics, contrasting the number of missiles hurled with the results achieved, the shooting seems even worse. It is only when the atomic or social systems break up or break down that we learn even of the existence of their real internal constitution.

Current Topics and Events.

ON July 30 there was read a third time in the House of Lords the Wild Birds Protection Bill introduced by Viscount Grey of Fallodon. The Bill aims at the repeal of existing enactments on the subject, and at substituting new provisions on lines recommended in 1919 by a Departmental Committee. The measure appears to us to be a wise one which should be welcomed by ornithologists and other bird lovers and also on grounds of economic importance. More than this, it is a much stronger measure than any of its predecessors, and if it become law and be properly enforced it should give a much more effective protection than is at present possible. The important new powers are those which are to make it an offence to be in possession of any bird, part of a bird, nest, or egg which may be presumed to have been illegally taken, and those which are to place the onus of proof on the possessor. At present, on the other hand, the onus is on the prosecution, and the act of killing or taking is the material fact to be proved: as a result, the skins and eggs of protected birds can be offered for sale with impunity by taxidermists and dealers, and "plovers' eggs" are freely sold in shops and restaurants in the close season. The Bill has still to be passed by the House of Commons, but we hope that this may be successfully accomplished next session.

AUGUSTIN LE PRINCE has rarely been recognised as one of the pioneers in kinematography. Mr. E. Kilburn Scott, who knew him personally, recently lectured before the Royal Photographic Society on his work in this direction, and a report of the lecture is given in the current number of the Society's Journal. Mr. Scott considers it established that Le Prince was the first to make a successful camera to take photographs at more than 16 in a second, was the first to show moving pictures on a screen (at Leeds in 1889), was the first to appreciate the importance of using flexible film (he is stated to have used celluloid films before September 1890), and was the first to use perforations and sprocket wheels (patents dated 1888). Le Prince's career came to an extraordinary end. He was last seen on September 16, 1890, at Dijon, entering a train for Paris, but since then nothing whatever seems to be known of him. One suggestion was that he might have been kidnapped by agents of American inventors whom he had forestalled.

THE Royal Geographical Society of Australasia (Queensland) is contemplating the investigation of the problems of the Great Barrier Reef, and is inviting other scientific societies and the universities of Australia to co-operate. In the *Queensland Geographical Journal* for 1920–22 Prof. H. C. Richards indicates some of the problems that await solution, and shows by a sketch of previous work on the subject how divergent are the views expressed on some important points. For example, it is apparently not known if the Great Barrier Reef is rising or falling or is in a static condition. The suggested investigations would include complete charting, including making vertical sections, of at least three island points on the reef, one each in the northern, middle, and southern regions, and recharting at intervals of a decade; charting of several of the more important troughs or valleys in the reef and the lagoon area, and recharting, also, at intervals of a decade; complete survey of the fauna, flora, and economic resources; and experiments on the growth of corals under varying conditions.

A COPY of a pamphlet has reached us on "Suggestions for the Prevention of the Decay of Building Stone," by Mr. J. E. Marsh (Basil Blackwell, Oxford, 1s. 6*d*. net). The author remarks in the preface: "In 1861 the Commission, appointed to stop the decay in the stone of Westminster Palace, decided to wait till a remedy had been discovered, and did not expect to have to wait long. We have waited sixty

years and seem to be no nearer a solution of the problem. . . . The preservation of our old historic buildings is a matter of as much concern now as it has ever been. Suggestions however slight may help. That is why this pamphlet has been written." Sections are given on Parliamentary commissions on the subject, theories of stone decay, and the treatment of stone, and the author describes experiments which he has carried out. The final sentences of the booklet are worth quoting: "The simple remedy is to keep the stone sterile. . . . This means, in simple language, keeping the stone clean. Alkalies have been used as cleansers from time immemorial. The walls of Oxford are sick; they have been drugged, but they have not been cleaned. What they need more than drugs is a good wash; for dirt rather than time is the destroyer of things."

Bergens Museums Aarsberetning for 1921–22 records the gift by the heirs of Herman Friele of that distinguished naturalist's cabinet of mollusca, mainly collected by him in the neighbourhood of Bergen, but also, in company with G. O. Sars, from northern Norway. It comprises in addition authentic specimens from the Atlantic and adjacent seas received in exchange from the leading specialists of his day. The number of specimens is 1650. This report also announces the commencement of work at the new biological station erected on the island of Herdla, 27 kilometres north-west of Bergen, where Herlö-fjord branches off from Hjelte-fjord, in a region already classic through the researches of Michael Sars. The station is provided with a small research sailing vessel, the *Herman Friele*, of 23 tons gross tonnage, with auxiliary oil-motor power.

THE University of Frankfort-on-Main has established an Institute with a professorship which is to deal with the applications of physics in medicine, *e.g.* radioactivity, X-rays, light rays, and the like. It is stated to be the first institute of the kind to be established in Germany.

THE Research Department of the Calico Printers' Association, Ltd., St. James's Buildings, Manchester, invites application for the post of a physicist whose duties will be to conduct research on physical problems arising in the calico-printing industry. The person appointed will work in association with the chemical research staff.

THE following are among the Civil List pensions granted during the year ended March 31: Miss A. H. Bacot, in recognition of the services rendered by her brother, the late Mr. A. W. Bacot, to science and to the nation, 75*l.*; Mrs. M. Barnwell, in recognition of the services rendered by her father, the late Dr. H. Woodward, to the cause of geological science, 25*l.*; Lieut.-Col. H. H. Godwin-Austen, in recognition of his services to science and to the nation, 100*l.*; Mrs. M. Lyster Jameson, in recognition of the services rendered by her husband, the late Dr. H. Lyster Jameson, to science, 50*l.*

BY the will of the late Mrs. Bacon, of New York, the Smithsonian Institution of Washington has received a sum of 10,000*l.* for the establishment of a travelling scholarship for the study of the fauna of countries other than the United States, in memory of her husband, Walter Rathbone Bacon. The scholarship will be tenable for at least two years, and the annual value about 500*l.* Applications for the award must include details of the proposed research, the benefits to be expected from it, the estimated cost, and full particulars of the scientific and physical qualifications of the candidate; they should reach the secretary of the Smithsonian Institution not later than October 1.

MR. J. S. HUXLEY informs us that, by an oversight, his name was omitted from the list of signatories to the letter on the forthcoming *British Journal of Experimental Biology* which appeared in NATURE of July 28, p. 133.

THE July issue of *The Fight against Disease*, the organ of the Research Defence Society, contains the report of the Committee for the year, and an abstract of Dr. Saleeby's lecture on sunlight and disease, with photographs of patients at Rollier's "sunlight school" at Leysin. Notes on smallpox and vaccination also occupy considerable space.

WE have received the twelfth report of the Microbiological Laboratory, N.S. Wales, for the year 1921. It contains a useful list of the species of fleas that occur on native rats. In some instances species of fleas appear to occur on marsupials and rodents indiscriminately. Some observations are also recorded on the Sydney milk supply, which on the bacteriological results seems to be of very poor quality. It is to be hoped that the publication of this annual report may be expedited in the future.

BULLETIN No. 25 of the Institute of Science and Industry, Australia, deals with "The Manufacture of Pulp and Paper from Australian Woods." The book itself is printed on paper made by the Institute in the course of the experiments described; a few sample sheets of paper of varying composition are also bound in at the end. The Bulletin is divided into five parts: General information; investigations (prior to 1920); laboratory investigations; semi-commercial experiments; economics.

WE have received a copy of the Nobel Lecture, "The Origins of the Conception of Isotopes," delivered by Prof. F. Soddy at Stockholm last December. This is a clear account of the development of radioactivity from its discovery by Becquerel in 1896 down to modern times. The conception of isotopes dates from 1905, though their complete chemical identity was not recognised until two years later. This identity was afterwards extended to include their electrochemistry and their spectra, but more recently infinitesimal differences have been found in the latter.

BULLETIN 53 S, issued by Messrs. Watson and Sons, Sunic House, Parker Street, Kingsway, London, illustrates the various medical uses to which high-frequency currents may be put. Use is made of the term violet-ray treatment; no doubt violet rays issue from the glass electrodes holding the gas under discharge, but it is open to question whether it would

not be better to retain the use of the term high-frequency treatment until it is definitely proved that the beneficial effects are due to the radiation. A large variety of electrodes suitable for the cavities and other parts of the body is illustrated, and instructions are detailed for their use.

THE British Medical Association (429 Strand, W.C.2) has published and issued a useful "Handbook for Recently Qualified Medical Practitioners" (price 2s. 6d. net). It gives concise but clear details of the duties of medical practitioners and of the legal obligations (by Dr. W. A. Brend) placed upon registered practitioners. The main careers open to members of the medical profession are summarised, and a section is devoted to post-graduation study and special diplomas. A section deals with the British Medical Association and its work, and the Dangerous Drugs Regulations are printed in an appendix.

PUBLICATION No. 110 of the Koninklijk Nederlandsch Meteorologisch Instituut is an important contribution to the oceanography of the Atlantic. It is a summary of about two and a quarter millions of observations made by steamers and sailing ships during March, April, and May throughout the period 1856–1920. There are 186 pages of tables and an atlas, with 24 plates. These represent currents, winds, the general circulation of the water and air, isobars, the general courses of water and air isotherms, and the limits of ice, fogs, etc. The tables were published in 1921 and the plates in 1922.

RECENT fishery publications include two papers from the Ministry of Agriculture and Fisheries ("Fishery Investigations"; Ser. II. vol. v., Nos. 5 and 6). No. 5, by Dr. W. Wallace, is a report on experimental hauls with small trawl nets made in the shallow waters of the North Sea in the years 1904-1912. No. 6 deals with the plankton collected during special cruises made in 1920-21 in order to estimate the annual production of plaice ova. The report is prepared by Mr. R. E. Savage. An important report (in continuation of earlier ones) on the life-history of the mackerel is contained in vol. xxx. of the reports (issued by the International Council for Fishery Investigations). This paper is the work of Dr. E. Ehrenbaum, of the Natural History Museum in Hamburg.

WE have received from the Eastman Kodak Company of Rochester, New York, the fifth volume of the "Abridged Scientific Publications from the Research Laboratory" of the Company. Owing to the increasing number of publications it has been decided to issue these volumes annually, and the present volume deals with the papers which were published during 1921. The abridgments are, of course, somewhat condensed as compared with the original papers, to which any one actually working at the subject dealt with would naturally refer, but for almost every purpose the abridgments will probably be found advantageous. Twenty-three communications are given in 172 pages, and there are added indexes of authors and subjects. This series of volumes forms a most valuable record of the activities of the Company's Research Laboratory, and incidentally a good indication of the general trend and progress of scientific photographical investigation throughout the world.

DR. G. ARNOLD's report as curator of the Rhodesia Museum, Bulawayo, for 1922, announces the completion of the new wing and the transference to it of the zoological collections and part of the ethnological material, thus freeing space for economic exhibits in the old building. As a result of Dr. Arnold's monograph on the sandwasps of the Ethiopian Region, the types of 70 new species have been added to the collection, a number that probably will be doubled. There are also accessions of type-specimens among bees, beetles, and Neuroptera, as well as the syntype of *Tangasaurus mennelli*, a lizard-like reptile from beds of Karroo age in Tanganyika Territory. Examination of the previously reported Codrington collection of ethnological objects has brought to light nine ceremonial staves of chiefs, from Kasembe's stronghold, such as could no longer be obtained to-day. Five Bantu spears with copper blades are evidence that the Bantu were more than capable of producing the metal weapons found at Zimbabwe. A female Bantu skeleton, found in an ancient mine-working near Gwanda, Southern Rhodesia, has been studied by Sir Arthur Keith, who considers it to date back 800 years or more. It will be seen that this report, though brief, indicates a great deal of good work.

MESSRS. ROSS LTD., optical instrument makers, have been awarded the diploma of the Grand Prix at the International Exhibition of Photographic Optics and Kinematographs held recently at Turin.

THE lectures delivered by Sir J. J. Thomson in April last on "The Electron in Chemistry," before the Franklin Institute, are being published singly in the Journal of the Institute. The complete series will shortly be published in book form under the title "The Electron in Chemistry."

IT is announced by Messrs. Longmans and Co. that the new edition of Thorpe's "Dictionary of Applied Chemistry," which is now in course of publication, will extend to seven volumes, and that a large part of the concluding volume will be devoted to an index to the complete work.

THE latest catalogue (No. 449) of Mr. F. Edwards, 83 High Street, Marylebone, W.1, is devoted to books, engravings, and paintings relating to the Indian Empire, and gives particulars of some 646 items, including geography and travel, ethnology, natural history, antiquities, etc. Among the works listed is "Annals of the Royal Botanic Garden, Calcutta," vols. 1 to 8.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have in the press a translation of "The Internal Secretion of the Sex Gland," Prof. A. Lipschütz, with a foreword by Dr. F. H. A. Marshall. The work will give an account of the recent experimental work

of Prof. Steinach and others on the reversibility of the sexes, the part played by the interstitial gland, and the results of the transplantation of this organ.

AMONG the books shortly to be published by the Cambridge University Press we notice "Stories of Scientific Discovery," by Mrs. D. B. Hammond, consisting of short biographical sketches of Priestley, Lavoisier, Count Rumford, Herschel, Fabre, Faraday, the Curies, Darwin, Wallace, and Pasteur; vol. 4 of the "Cambridge Medieval History," dealing with the Eastern Roman Empire (717–1453), and "Foundations of Agricultural Economics," by J. A. Venn; the aim of the latter is to give some account of the origin and incidence of the numerous economic problems which affect the agricultural community.

Our Astronomical Column.

AN OFT-RECURRING RELATIVITY BLUNDER.—Many people have been temporarily misled by a fallacy in considering the Einstein bending of rays of light. They imagine that it ought to produce a sensible shift in the position of the further component of a double star, owing to its light passing close to the nearer component, or similarly that the satellites of Jupiter ought to undergo the shift at the time of occultation. Another form of the fallacy is put forward by M. de Saussure in *Astr. Nachr.* No. 5235, in an article entitled "Influence de la déviation des rayons lumineux sur la valeur du diamètre du soleil." He notes that the light from each limb of the sun would be subject to the Einstein bending, but that since it has only traversed half the gravitational field as compared with a star behind the sun, the bending at each limb is $1·75''/2$. So far he is correct. His error comes in when he asserts that the true diameter of the sun is $1·75''$ less than that measured, equivalent to 1300 km. In fact we only see the full Einstein shift when the distance from the eye to the place of bending is small compared with the distance from the eye to the object viewed. This is obviously the case for a star near the sun, but not for the components of a double star, for Jupiter's satellites or for the sun's limb.

Since the Einstein bending is similar to refraction we can easily see the fallacy by the following example. Take a bowl 6 inches deep, and let a mark on the bottom be just brought into view to an eye placed horizontally behind the edge of the bowl, when the latter is filled with water. Then the mark is seen deflected through some 41·4° from its true place. But if the eye be placed a mile away, still in the same level, the deflection is no longer 41·4° but only $19·5''$. Similarly in the case of the sun's limb, the principal bending takes place near the sun, and the enlargement of the sun's diameter is not $1·75''$ but only about $0·01''$; practically a negligible quantity.

SPECTROSCOPIC PARALLAXES.—The Memoirs of the R.A.S., vol. 62, contains a valuable paper by Mr. W. B. Rimmer on the spectroscopic parallaxes of 500 stars, the types of which range from Fo to Mb. The spectra were photographed at the Norman Lockyer Observatory, Sidmouth, with the 12-inch prismatic camera formerly belonging to Dr. F. McClean; a few of his spectrograms with the same instrument are also discussed. The differences of line-intensity were measured by the wedge extinction method devised and recently described by Dr. Lockyer. A special study was made of the means for obtaining uniform results, and cases of discordant readings were remeasured. A search has been made for additional pairs of lines suitable for the purpose, besides those used at Mt. Wilson; the enhanced titanium line at 4444 was successfully adopted in conjunction with the cadmium line at 4455; the pair 4216, strontium, and 4250, iron, is available for all types of spectra from F to M; other pairs have a limited range of applicability.

In drawing curves connecting line-intensity with absolute magnitude, use was made of all the trigonometrical parallaxes deduced by recent methods, equal weight being given to all; $0·005''$ (in Mt. Wilson values $0·002''$) was added, as the reduction to absolute parallaxes. Some of the curves are reproduced in the Memoir. The catalogue contains no dwarf stars of types M or late K, as the spectra available from which to draw curves are too few.

All the 500 stars are in the Mt. Wilson spectroscopic catalogue, and its results are printed for comparison, the agreement being very satisfactory, especially in view of the complete independence of method of measurement. The parallax found for Arcturus is $0·145''$ as compared with $0·158''$ at Mt. Wilson, and $0·100''$ (trig.) at Yerkes; its absolute magnitude is 1·0; it therefore appears to be less remarkable for size and speed than was formerly thought. The brightest absolute magnitude in the catalogue is ϵ Geminorum, −1·5; the faintest are seven stars of mag. 6·0 and 6·1.

YERKES OBSERVATORY: TWENTY-FIFTH ANNIVERSARY.—The Yerkes Observatory celebrated its twenty-fifth anniversary last September; the address delivered on the occasion by the director, Prof. Edwin B. Frost, has recently been printed. He emphasises the paramount part played by Prof. G. E. Hale in its establishment. The spectroheliograph had recently been invented, and work with that instrument has been throughout a principal feature. The original spectrograph being inadequate for this work, part of the funds bequeathed by Miss C. W. Bruce were devoted to the spectroscope called after her, and more than 8000 stellar spectrograms have been obtained with it. These have already yielded many important results, though the information contained in them has not yet been fully investigated.

The 60-inch mirror was offered to Yerkes Observatory, but it was felt that it would have a wider field of usefulness at Mt. Wilson.

Visual work with the 40-inch refractor included Prof. Burnham's measures of double stars, and Prof. Barnard's work on clusters, nebulæ, comets, faint satellites, etc. It was also found that the instrument could be efficiently used for photography, by placing a yellow filter in front of the plate, which must be isochromatic. Successful photographs have been made of the moon, planets, nebulæ, and clusters; 6700 plates were taken for star-parallax. Allusion is made to Barnard's splendid series of photographs of comets, and the Milky Way; the Atlas of the latter is stated to be nearly ready for publication.

The total solar eclipses of 1900 and 1918 were observed by members of the staff, and arrangements are being made to observe that of next September in California. It is pleasant to learn that the observing conditions at Yerkes are probably the best that could be obtained within 500 miles of Chicago; the 40-inch instrument can be used for some 1700 hours per year.

The record of work is one of which the Observatory may well be proud.

Research Items.

THE QUIPU MYSTERY.—Twenty years ago the method of counting by the knotted Quipu was one of the mysteries of Peruvian archæology. Since that time several explorers have found them in use by shepherds in keeping account of their flocks. More modern Quipus are easily understood and can be used by any one. Prof. L. Leland Locke, to whom we are largely indebted for the solution of the problem, has now prepared for the American Museum of Natural History an elaborate, well-illustrated monograph in which all available evidence concerning the use of the Quipu as a means of counting has been carefully collected.

TATTOOING IN THE MARQUESAS.—In Bulletin No. i. of the Bernice P. Bishop Museum, Mr. W. G. Handy publishes an elaborate, well-illustrated monograph on tattooing in the Marquesas. The operation was extremely painful, and after each sitting local inflammation, followed by fever or swellings, persisted for a period of eight or ten days. The practice has now ceased, and the facts have been collected from an examination of about a hundred and twenty-five of the older generation. The designs, of which numerous illustrations are given, show much artistic taste. It cannot now be ascertained how far the practice possessed a magical significance, but in one case a woman seems to have been marked to protect her from evil spirits. But at the time of the cessation of the art it had become purely decorative.

STONE YOKES FROM MEXICO AND CENTRAL AMERICA.—Excavations in Mexico and Central America have disclosed certain objects of unusual and definite shape and of wide distribution, the function of which is unknown. The stone yoke is shaped like the letter U and is about two feet in height, with the bevelled outer surface often carved with elaborate designs. It has been impossible to identify these objects either in native manuscripts or in the many available examples of sculpture in stone and clay. The evidence now collected by Mr. S. K. Lothrop in the July issue of *Man* shows that the stone yoke was worn round the waist and that it served no utilitarian purpose. The suggestion now made is that the yoke may represent the underworld, because the outline resembles the Mexican symbol for that region, and also because the yoke is associated with death and sacrifice in the Santa Lucia sculptures. But the proof of this theory must await the presentation of new facts.

AIR SURVEY AND ARCHÆOLOGY.—Mr. O. G. S. Crawford has reprinted his paper on "Air Survey and Archæology," read before the Royal Geographical Society in March last. The main purpose of the paper was to distinguish by the aid of ground-plans and aerial photographs of camps like Cissbury and the Soldier's Ring near Martin, now in Hants, two varieties of the shelves and banks, known as lynchets. The first, or Celtic type, he attributes to the first wave of the Celtic-speaking peoples about 700 B.C., who introduced finger-tip pottery, new types of bronze implements, the use of iron, square camps, and the Celtic system of lynchets, boundary-ditches, and roads. The Saxon or "open-field" system was quite different from the Celtic type, and this is instructively illustrated by sketch maps of the Celtic and Saxon villages on Salisbury Plain. Mr. Crawford writes: "I find it difficult to express in suitable words my sense of the importance of air-photographs for archæological study. They provide a new instrument of research comparable only to that provided by excavation. They are second only to excavation in the results they will achieve. Their invention will prove as valuable to archæology as that of the telescope has proved to astronomy. They are not a substitute for field work, but they are the most powerful ally of the field archæologist."

THE PRESENT POSITION OF DARWINIAN THEORY.—In an article on this subject in the current number of *Science Progress*, Prof. E. W. MacBride first outlines Darwin's own position as developed in the first five chapters of the "Origin of Species." Among the points he emphasises are Darwin's belief that modifications due to use and disuse are inherited, and his view that acclimatisation and the inheritance of its effects must have played a part in evolution. After stating eight "laws" of Darwin, Prof. MacBride concludes that they are reducible to two: (1) the Lamarckian factor, (2) an indefinite tendency to vary to an unlimited extent in all directions. The second factor he discards after a discussion of mutations in several of their aspects. To reach this conclusion he relies upon the principle of regulatory balance, and states that the doctrine of the survival of the fittest implies that all the organs of an animal (or plant) shall be useful, meaning that the particular specific form or character of every organ must be useful. The article concludes with a discussion of recent evidence concerning the inheritance of acquired characters, a criticism of the age and area hypothesis, and a short reference to recapitulation.

BIO-CLIMATIC STUDY IN THE EGYPTIAN DESERT.—Bulletin No. 29 published by the Ministry of Agriculture, Egypt, gives a short discussion on the above by Mr. C. B. Williams, senior entomologist. The discussion is carried out to show that the statistics gathered by meteorologists relative to desert conditions greatly ignore the conditions for biological studies. The author, while approving of the Stevenson screen for meteorological purposes, suggests that there is a strange lack of Stevenson screens for sheltering purposes in the desert. An expedition was made for a week in August 1922, all the time that could be then spared, to get at the actual facts of local variation. The locality chosen was in the Wadi Digla, 12 miles south-east of Cairo and 7 miles in a direct line from the Nile. Observations were made at the camp on the south side of the wadi, mostly shaded from the sun; also just alongside the camp, on the rock, beneath a large piece of which was a cavity into which it was possible to crawl, and on a large flat-topped rock in the middle of the wadi, completely exposed, where black and white bulb thermometers *in vacuo* were observed. Other observations were made in a body of sand, in a burrow, in a bush, in a hole under stone, and in ant-lion pits. During the week the temperature of the surface sand showed a change from 17·5° to 58·2° C., while the air shade varied from 21·2° to 35·9° C., and twelve metres in a cave from 24·0° to 25·4° C. only. There was a great range of humidity and other conditions in the various positions.

COWS' MILK FOR HUMAN CONSUMPTION.—A conference on the milk question was held at the meeting of the Royal Society of Arts on April 25, of which an account is given in Journ. Roy. Soc. Arts, June 29. Prof. Stenhouse Williams maintained that it is not an impossible proposition to provide the public with a clean raw milk from cows which do not react to tuberculin, at a price which consumers ought to be, and are, willing to pay. Prof. Drummond, Dr. Zilva, and Capt. Golding dealt with the changes which take place in cows' milk on heating to various temperatures—

digestibility, influence on vitamins and enzymes—suggesting that it is inadvisable to employ heated, such as pasteurised, cows' milk for infant feeding. They seem to have overlooked the fact that cows' milk is not the natural food for the human infant, and that clinical evidence does not support the view that good fresh heated cows' milk is less satisfactory for infant feeding than the raw milk.

LANCASHIRE SEA-FISHERIES.—In his introduction to the report for 1922 on the Lancashire Sea-Fisheries Laboratory, Prof. James Johnstone has given an interesting summary, in non-technical language, of the present state of knowledge concerning the problems under investigation. Mr. Daniel's third and concluding paper on the seasonal changes in the chemical composition of the mussel (*Mytilus edulis*) deals with the distribution of fat and glycogen in the tissues, and he shows that it is the rôle of the connective tissue to store up these substances as reserve food-materials, afterwards to be used up by the rapidly growing sexual follicles during the time of preparation for reproduction. The study of the Irish Sea cod-fishery of 1921–23 by Messrs. Johnstone, Smith, and Fleming has led to the conclusion that there is no such definite seasonal variability in the metabolism of Manx cod as one finds in the herrings from the same district. Mr. Birtwistle and Miss Lewis conclude their report on scale investigations of shoaling herrings from the Irish Sea with a pertinent question :—" How are we going to reconcile these two positions, namely, that we can construct a curve from a sample of herrings which suggests that variations in length and scale rings are due to chance and do not indicate age, and at the same time we can construct a similar type of curve from a sample of plaice in which we do definitely know that the variations in length and otolith rings do indicate four different age groups ? "

LACE-WING FLIES.—Memoir 58 of the Cornell University Agricultural Experimental Station is devoted to an account of the biology of the Chrysopidæ written by Mr. Roger C. Smith. The insects included in this family are of particular interest in view of their predaceous habit of destroying various soft-bodied insects, etc., particularly Hemiptera. About sixty species of lace-wing flies are known in the United States, and the life-histories of eleven are described and illustrated with evident care. The general discussion of the family, which runs to about 50 pages, is particularly interesting, and should be read by all who study these insects. In discussing the function of the long pedicel, upon which each egg is laid, the author points out that it only affords partial protection from enemies. Only certain species of the larvæ carry debris on their backs and have specially modified setæ for retaining the material in position. The debris is used as a method of concealment, and consists of varied substances, including particles of plant tissues, exuviæ, and other insect remains. This material is placed by the larva on its back, but no silk is utilised in building it together. The larval food consists chiefly of eggs and small aphids and scale insects, but the larvæ are sometimes cannibalistic. It has also been observed that they frequently derive sustenance from plant tissues. The average number of aphids eaten by one of these insects during its larval life is about 170. Certain of the adult insects are also noted to devour aphids very readily. Chrysopids are subject to various insect enemies, and one of the most remarkable is a small blood-sucking midge, which attaches itself to the wings of the lace-wing and, burying its proboscis in a vein, sucks up the blood of its host.

JAPANESE TERTIARY FOSSILS.—Prof. M. Yokoyama, to whose valuable papers on the fossils of the Musashino beds we have previously directed attention (NATURE, August 26, 1920, p. 836, and November 11, 1922, p. 646), has now published a note " On some fossil Mollusca from the Neogene of Izumo " (*Japan. Journ. Geol. and Geogr.*, vol. ii. No. 1). The exact horizon of the beds is uncertain ; they are older than the Musashino formation, and if Pliocene should be referred to the Lower and not to the Upper division. Out of 19 species described, setting aside three as possibly obtained from beds not belonging quite to the same formation, there are seven species referable to existing forms and seven not known living which are here described as new. The relative proportion may, however, be modified on the acquisition of additional specimens.

THE GIGANTIC HORNLESS RHINOCEROS. — Prof. H. F. Osborn has followed up his scientific description of the skull of Baluchitherium, to which we referred recently (NATURE, July 14, p. 67), by a popular article on it and other rhinoceroses living and extinct (*Natural History*, vol. xxiii.). Well written and abundantly illustrated, this article is worthy of attention by more advanced students than those for whom it is obviously designed. So far as we are concerned the most interesting feature is the evolution of the idea as to Baluchitherium's size and form as expressed in three successive restorations. In the first it appears like an exaggerated rhinoceros with a proportionately slightly longer neck, while the last exhibits a slighter limbed, more upstanding animal, with elongate, horse-like neck, its height at the shoulder being increased in terms of a modern rhinoceros from 1·8 to 2·5. Its affinities to other rhinoceroses is yet in doubt ; but for its powerful superior tusks it would be considered as simply a giant Aceratherium.

OIL-SHALE FROM THE ROCKY MOUNTAINS.—Mr. D. E. Winchester has recently contributed a useful addition to the oil-shale literature of the United States Geological Survey in Bulletin 729, wherein he describes the well-known occurrences of the Rocky Mountain region. This volume is noteworthy because the author discusses an aspect of the subject usually slurred over by most writers, namely, the detailed fauna and flora of certain stratigraphical horizons to which the oil-shales are referable. The fauna includes a long list of insects (in the broad sense) and other arthropods of the Green River Formation (Eocene), while an abundant and varied flora has been described by Mr. F. H. Knowlton, the late Dr. C. A. Davis's contribution on the study of the micro-organisms being also incorporated in the text. The photomicrographs of thin sections of some of these oil-shales show an abundance of fossil vegetable-matter with which, presumably, the hydrocarbon content of the shale is connected. Some interesting data are recorded concerning methods of approximate evaluation of oil-shale in the field, the methods including simple retorting and test-tube experiments, the latter being especially useful. After all, even if there be millions of tons of shale-resources available for mining, the material is of little use unless it will yield oil in payable quantities. Hence field-tests, where definite, may save a great deal of unnecessary expense in initial development. This bulletin is profusely illustrated with photographs and maps, and a very complete oil-shale bibliography is appended ; it is, in fact, something more than a mere technical report, being a trustworthy handbook to the whole subject of oil-shale mining and exploitation.

WEATHER IN EGYPT.—The meteorological report for the year 1918 has recently been issued by the

Ministry of Public Works, Egypt. Daily observations are given for several elements at the principal stations, comprised by Helwan Observatory, which is the first-order station for Egypt, as well as Alexandria, Giza, and Khartoum. Monthly summaries are given for many other stations, and monthly rainfall results are added for several places. Weather conditions were generally unsettled from January to April and from October to December, but more settled weather was experienced from May to September. The temperature was much above the normal in the autumn months and about normal for the rest of the year, while atmospheric pressure was generally above the normal. Heavy rain of the thunderstorm type over Middle Egypt was a feature of the year. The Sudan rains were in considerable deficit. At Helwan, July was the hottest month of the year and the diurnal change of temperature was greatest; the mean temperature was 28·8° C., and at 5 A.M. the deficit of temperature was 6·7° C., while at 3 P.M. there was an excess of 6·7° C. The lowest mean temperature was 12·6° C. in January. The total rainfall for the year at Helwan was 36·7 mm. (1·45 in.), and no rain fell from June to September. Observations were commenced at Jerusalem in April 1918; the hottest month was July with a mean 22·8° C., while in December the mean was 10·0° C. No rain fell in June, July, and August; in December the total rain was 105·1 mm. (4·14 in.).

PECTIN IN COTTON.—Messrs. P. H. Clifford and R. G. Fargher have been examining the distillate from large-scale experiments upon the treatment of cotton with sodium hydroxide and superheated steam, conducted by the Bleachers' Association, Ltd. (Journal of the Textile Institute, vol. xiv. No. 5, May 1923). Methyl alcohol and acetone were the main volatile products isolated, a fact which supplies additional evidence for the presence of pectin in the cotton hair, as F. Tutin has shown (*Biochem. Journ.*, vol. 15, 1921) that the alkaline hydrolysis of pectin yields both these substances.

X-RAY INSTALLATION FOR VETERINARY WORK.—The Research Department, Woolwich, has published a description of an X-ray equipment, designed and constructed at Woolwich, which has been installed in the Army Veterinary School at Aldershot (R.D. Rep. No. 56). It consists of a large teak table-top to which the animal can be strapped while in the vertical position. The X-ray tube box is mounted on a carrier which enables it to be moved into any position relative to the animal, and the examination may be made or radiographs taken with the animal in the upright position. Alternatively, the table-top may be rotated and moved on rollers so as to bring the animal into the horizontal position over a supporting table. The X-ray tube used is of the standard Coolidge type, completely enclosed for protection in a lead box, and the generating set is designed to supply currents up to 20 milliamperes continuously at 150,000 volts. Full details of the apparatus are given.

INDUSTRIAL PSYCHOLOGY IN COAL MINING.—To attempt to teach a coal miner how to use a pick seems at first sight as valuable as taking coal from Dover to Newcastle; but a glance at two memoirs by Dr. C. S. Myers and Mr. E. Farmer in the June issue of the Memoirs and Proceedings of the Manchester Literary and Philosophical Society is sufficient to show how much is to be gained by investigating scientifically the best way of using such a tool. Mr. Adams and Mr. Stephenson, two post-graduate students of the Psychological Laboratory of the University of Manchester, have devoted twelve months of their time to the investigation, and have for much of this time lived the life and worked the hours of the miner. As a result, the wielding of the pick has been rendered more continuous and rhythmic and a greater output secured with less fatigue of the miner. The effects of improved lighting and more orderly arrangement of work so that less shovelling has to be done have also been investigated, and the miners themselves have taken a keen interest in the investigation.

A MERCURY FLASH-LIGHT FOR PHOTOGRAPHY.—In the Proceedings of the Physico-Mathematical Society of Japan for June there is reprinted a paper from the *Japanese Journal of Physics* by Kyoji Suyehiro on an "Electrically deflagrated Mercury Filament as a Flash-light for Instantaneous Photography." In investigations on the rolling of model ships and the vibration of structures, photographs of rapidly moving objects were desired. Prof. Anderson's experiments on electrically deflagrated wires as a source of light led to a trial of this method with fine tin and copper wires, but the results were not encouraging. Filaments of mercury were tried with success. Mercury is sucked up into a glass capillary tube, and in each end of the tube a "hair wire" is secured with sealing-wax. Thus filaments of any size are easily prepared. The duration of the flash is shorter as the filament is reduced in length and diameter, and it is also affected by the thickness of the wall of the tube. The most intense light is given out by the mercury arc lit just *after* the explosion. The paper is illustrated with photographs of flashes, results of testing their duration by means of a rotating disc with radial lines on it, and applications of the method.

MANUFACTURE OF WATER-GAS.—The Fuel Research Board of the Department of Scientific and Industrial Research has just issued, in its Technical Paper No. 6, a record of experiments at H.M. Fuel Research Station, Greenwich, on the "Comparison of some Methods of running Water-Gas Plant" (H.M.S.O., 2*s*. net). The manufacture of water-gas from coke is of great economic importance, and the accumulation of carefully ascertained data is correspondingly valuable. Observations were recorded on the behaviour of cokes of different origin when used in the generator (of the Humphreys and Glasgow pattern), and the paper deals also with four gasification tests with varying depths of fuel bed. The first three were made on the Dellwik-Fleischer system—with shallow beds of depth 3 ft. 6 in. to 4 ft. and varying rates of steaming. The fourth was made with a deeper bed on the system recommended by the makers. All tests were made on the same coke. The observations in the tests are given very fully in tables of weight and thermal balances, temperatures, and rates of gas production. The thermal efficiency of the generator was found to reach 59·9 per cent. in the Dellwik-Fleischer system and 57·8 per cent. under the normal regime, when no deduction was made for heat losses and expenditure in generating the power employed in the process. These deductions depend naturally on the efficiency of the auxiliary plant, and might depress the efficiency on certain conditions assumed, *e.g.* in the fourth test to 52·8 per cent. The greatest thermal loss occurred in the heat carried by the "blow gas" which lay in the four tests between 20 and 30 per cent. and sufficient theoretically to generate 80 to 130 lb. of steam per 1000 cu. ft. of water-gas made. This report may usefully be read in conjunction with the Sixth, Seventh, and Tenth Reports of the Gas Investigation Committee of the Institution of Gas Engineers published in 1921, 1922, and 1923, which give a more detailed study of the water-gas process in its various modifications, as operated in towns gasworks.

International Education.

"THERE is hardly any important national problem left in the world which has not an international relation and aspect." "The search for truth and its application to human need is a vast, world-wide co-operative task. . . . Every country should seek entangling alliances in a league for scientific progress." Of these quotations the first is from a speech made recently in London by Dr. Nicholas Murray Butler, the second from a report, published last year, by the president of the Rockefeller Foundation. Both indicate a point of view which has been adopted with enthusiasm since the War by a considerable number of people, especially in academic circles, in the United States. Both in America and on this side of the Atlantic, where it is more familiar, systematic efforts have been made to orientate higher education to some extent to this supra-national point of view.

In America two important organisations have been established expressly for the furtherance of International Education—the Institute of International Education by the Carnegie Endowment for International Peace, and the International Education Board by John D. Rockefeller, Jr. The Board, which only came into being this year and aims at promoting "education throughout the world," has made a grant of 100,000 dollars a year for ten years to Teachers College, Columbia University, to aid in establishing, as an integral part of the College, an International Institute for the instruction of foreign students (of whom there are already some 250 in the College) and of Americans engaged in teaching in foreign countries, and for research and investigation into foreign educational conditions and the adaptation to those conditions of American systems and methods of education. The Board aims at establishing mutually helpful relations with other countries in regard to selected specific educational problems, and has already arranged for a study of co-operative farming methods in Denmark. Many of the activities of the Rockefeller Foundation, with which the Board is closely associated, have an international educational character: of the 157 individuals who held the Foundation's fellowships in 1921 only 71 were Americans, the others belonging to 17 other nationalities.

The Institute of International Education began work in 1919, and its director, Dr. S. P. Duggan, has recently presented its fourth annual report. Among its varied achievements during 1922 was an agreement with the Commissioner of Immigration at Ellis Island, designed to mitigate in its application to students the new American immigration law limiting to specified quota the number of immigrants from foreign countries, the director undertaking to act as sponsor for properly certificated students and the commissioner agreeing to admit such students provisionally on parole. Among its other enterprises may be mentioned: arranging for the selection and distribution of 45 fellowship-holders from France for study in the United States and 35 from the United States for study in France; acting as agent for the Spanish Junta para Ampliación de Estudios, which sent 6 fellowship holders to the United States, and for the Czechoslovakian Government, which sent 5; assisting the French authorities to select French girls for training, partly in France and partly in America, in library work and public health nursing; securing fellowships in American institutions for foreign students; promoting resort by Americans to summer sessions in foreign universities; organising student tours in Italy, France, England, and Scandinavia; arranging exchanges of professors; and promoting the formation of International Relations Clubs for the discussion of international questions. The Institute has now an established place as one of the most influential of existing organs for the development of intellectual intercourse among the nations of the world.

In Great Britain the most important single endowment of international education is that provided by the Rhodes Scholarship Trust. Provision is now made under the trust for the continuous residence at Oxford of 190 scholars selected from English-speaking countries outside the United Kingdom. A peculiarity of the method of selection for these scholarships is an insistence on moral force of character, capacity for leadership; in short, all-round ability, as well as literary and scholastic attainments. A similar principle is prescribed for selecting candidates for the 6 Henry P. Davison scholarships founded this year to provide for Oxford and Cambridge men spending a year at Harvard, Princeton, or Yale. A few scholarships similarly designed to draw students from abroad are offered by certain Cambridge Colleges, the Imperial College, and the universities of Liverpool, Manchester, McGill, Harvard, Princeton, and Yale, most of them being open only to students of countries within the British Empire.

Conversely, many universities have endowments, such as the Craven Fund and Radcliffe travelling fellowships fund, which encourage students to go abroad for study or research, generally in some specified field, such as modern languages and institutions, classical studies, or the fine arts, in which sufficient facilities are not available at home. Similarly various governments and voluntary associations, such as the federations of university women, the Anglo-Swedish Society, and the Canadian Imperial Order Daughters of the Empire, have instituted scholarships enabling students to travel to distant countries for educational purposes. The Government of Panama, for example, periodically sends two carefully selected students to universities in Great Britain for complete degree courses of study. The Albert Kahn travelling fellowships, open to British graduates of universities of the United Kingdom, are remarkable for their breadth of aim—"to enable men . . . to enter into personal contact with men and countries they might otherwise never have known; to issue from the world of books . . . into the broader world of . . . all such human interests, struggles, and endeavours as go to the making up of general civilisation."

Apart from endowments for encouraging international education by scholarships and fellowships there are many influences, some of quite recent origin, having a similar tendency. The universities of the United Kingdom have instituted a new doctorate, the Ph.D., open to graduates of foreign universities as well as to their own, and have organised in connexion therewith instruction in research methods; their laboratories and other equipment for advanced study and research have been greatly developed; their representatives have taken part in missions to American, French, Belgian, and Swiss universities; they have established a standing committee of their executive heads with the Universities Bureau as its secretariat, and a separate committee for promoting interchange of students and teachers with universities in other lands—a purpose which has been greatly furthered by the constitution of the British divisions of the American University Union and the Office National des Universités et Écoles Françaises, both of which have offices in the house belonging to the Universities Bureau. There

has also been a notable development of short summer-vacation courses (mainly in London) for foreign students as well as of other summer courses, to which, although not planned expressly for them, foreigners are admitted. Interchange of school teachers (for periods not exceeding one year) between England and Wales and the Dominions overseas has been organised by the League of the Empire on a large scale, and other bodies such as the Overseas Educational League and the Fellowship of the Maple Leaf, are engaged in similar enterprises.

Several European countries participate in exchanges financed by American educational endowments. The Commission for Relief in Belgium Educational Foundation of New York arranges, in concert with the Fondation Universitaire of Brussels, grants for study in American Universities to Belgian graduates and vice versa (in 1921–22, 34 and 24 respectively). The American-Scandinavian Foundation similarly allots 40 travelling fellowships, each of 1000 dollars, and the Franco-American Scholarship Exchange, administered by the American Council on Education, provides 50 scholarships for French women in American colleges, 28 for American women in French lycées and écoles normales, and 22 fellowships for American graduates in French universities.

In France the Doctorat d'Etat has been made more accessible to foreign graduates, a system of exchanges of professors has been arranged with certain American universities, and the summer-vacation courses for foreign students in vogue before the War have been re-established and extended. In 1919 a Franco-Swiss interuniversity conference took place, and in 1921 a convention was concluded, between the French and Belgian ministries of public instruction, to encourage and regulate the exchange of professors and students and to establish a permanent technical commission for the study of questions regarding the scientific, literary, artistic, and scholastic relations between the two countries.

In the same year, 1921, were formed the Netherlands Committee for International Academic Relations and the Office Central Universitaire Suisse.

The Confédération Internationale des Étudiants, formed in 1919, has contributed substantially in co-operation with its affiliated national unions, towards familiarising students with the idea of migration. The National Union of Students of England and Wales, constituted in 1922, has been very active in promoting visits by students to universities in foreign countries.

In the nineteenth century one of the most powerful influences making for migration of students was the great reputation of the German universities for profound learning and for primacy in scientific research, together with their liberal conditions of entrance. In the United States especially a German doctorate came to be looked upon as a normal culmination of the studies of an ambitious youth. The tradition was fostered by the system of exchange of professors arranged by the Prussian ministry of education with American universities. Before the War, however, a reaction had set in, due in part to the rapid development of the American graduate schools.

The League of Nations decided last year to enter the field of International Education, and a Committee on Intellectual Co-operation, having a sub-committee on Interuniversity Relations, is actively engaged in devising ways and means of stimulating movements and enterprises such as those mentioned in this article, including the establishment of an international bureau of university information.

The question of interchange of students has an economic aspect which deserves study. At the present time students from abroad constitute about eight per cent. of the full-time students in the universities and university colleges of the United Kingdom. Statistics showing the number of students from the United Kingdom in universities and colleges in all other countries are not available, but those in the United States in 1920–21 numbered 181, and those in other parts of the world are certainly very few compared with the total of more than four thousand students from abroad in the British Isles. Is the fact that our imports so largely exceed our exports to be accounted economically advantageous to us or the reverse? The fees paid by students represent, of course, only a fraction of the costs of maintenance of the institutions where they study, and in universities such as Oxford, Cambridge, London, and Edinburgh, which are frequented by students from abroad in large numbers, the additional expenditure necessitated by their attendance is probably not compensated by their fees; but there is a more important question in regard to the students who come to Great Britain to study technology. When they go back to their own countries they take with them knowledge which is used so as to make the competition of their countries' industries with our own more formidable. On the other hand, they are likely to recommend the placing of orders for stores and machinery in the country in which they have studied rather than in other countries, and if they had not come to Great Britain for their knowledge they would probably have obtained something very like it elsewhere. It may be that such students do British industries more good than harm. The matter is one on which it is desirable that further light should be, if possible, obtained.

Botanical Surveys.

THE Department of Agriculture of South Africa has recently issued two memoirs (Nos. 3 and 4) on the botanical survey of South Africa. The former, by S. Schonland, entitled "Introduction to South African Cyperaceæ," is a systematic account of a selection of the indigenous sedges, many of which play an important part in the prevention and cure of soil erosion, and a knowledge of which is essential in the study of the relations of sour and sweet veld. A description of the general structure of the vegetative organs, the inflorescence, the difficulties in the interpretation of which are discussed in some detail, the flower and the fruit, is followed by notes on all the South African genera, including representative species of each. The species are illustrated by seventy carefully drawn plates, which show the habit of the plant and enlarged details of flower and fruit, and will enable the student to identify any species included in the limits of the book. The general arrangement is the one adopted in the "Flora Capensis" by the late Mr. C. B. Clarke, to the thoroughness of whose work Dr. Schonland pays high tribute. The critical remarks included in the notes on the genera render the work of value to others than the South African student of this family.

Memoir No. 4, entitled "A Guide to Botanical Survey Work," is a series of chapters, by different experts, which will be helpful to those engaged in the South African survey. Dr. Pole Evans reiterates the organisation and aims of the survey, and describes briefly the characteristics of the two main botanical regions, the true Cape region, with a vegetation resembling in its general aspect that of the Mediterranean area, and the South African region, which

comprises the remainder of the country under review, extending northwards to include a strip of Southern Rhodesia and the southern part of Portuguese East Africa. There are also chapters on the physical features and climate, on methods of survey, with instructions to collectors and observers, and a bibliography. Dr. Marloth writes on the use of the common names of plants, which, though sometimes not trustworthy, may be very useful if accepted with care and discretion.

The Report of the Canadian Arctic Expedition 1913–18 (vol. v., Botany, part B) by Theo. Holm ("Contributions to the Morphology, Synonymy, and Geographical Distribution of Arctic Plants") contains some interesting notes on the methods of growth and reproduction, manner of hibernation and other characteristics, of many of the species collected by the expedition. Certain biological types are absent from the polar regions; there are no climbers, no saprophytes, and no true parasites. Pedicularis alone represents the partial parasites. The great majority of the herbs are perennial. The chapter on geographical distribution contains a table showing the general distribution of the species collected, which indicates that the vegetation of the north coast of America is composed of types from various parts of the northern hemisphere of both worlds, and bears out the view that the present arctic flora consists to a great extent of remnants of the alpine floras of the tertiary period. These alpine floras were principally those of the European Alps, Altai and Baikal, the Rocky Mountains, and perhaps also Caucasus and Scandinavia.

Memoir 126, issued by the Canadian Department of Mines ("A Botanical Exploration of the North Shore of the Gulf of St. Lawrence," by Harold St. John), includes an annotated list of all the flowering plants and ferns recorded from this area, in all 622 species, and some discussion of the soil-relations of the various ecological plant groups. A comparison of the habitats of 103 species along the north shore of the gulf and in other regions, especially Europe, indicates an agreement the more surprising considering that the data have been gathered by many botanists at widely separated places and times. Mr. St. John also gives an account of botanical exploration in the same area previous to his own visit in 1915.

"A Flora of the Shetlands," by Dr. G. C. Druce, forms a supplement to the recently issued report of the Botanical Society and Exchange Club for 1921. The total land surface of the islands, which number more than a hundred, is rather more than that of the Faroes, but the hills are lower and lack the marked alpine element found in the flora of the Faroes. The population of the islands since the glacial period has been explained alternatively by the existence of a land-bridge and immigration by means of birds, ocean-currents, and wind. The latter view would seem the more probable. There are practically no endemic species, and many species found in the islands are extremely local. The flowering plants and ferns number about 500 species, 59 of which have probably been introduced by man. Dr. Druce remarks on the size and brilliancy of some of the flowers, and suggests the feeble intensity of sunlight as a cause; clouds are absent from the sky only on a few days in the year, and mists are very frequent. There are few Lepidoptera; many plants are self-pollinated, and others never ripen seed. The flora approximates most closely to that of the Faroes, and is distinctly poorer than that of the Orkneys.

The Gas Industry and Coal Conservation.

THE annual coal output of Great Britain is about 300 million tons, of which approximately 20 million tons are carbonised annually in gasworks for the production of towns' gas. The reserves of British coal within 4000 feet of the surface were estimated in 1915 at 197,000 million tons. In something like 600 years the coal measures of this country will be probably exhausted, and what then? The world's scramble for oil to-day indicates that a coal age will certainly not be succeeded by an oil age. Possibly we shall have learnt to tap atomic sources of energy, or perhaps the earth's internal heat may be available to us, after the manner suggested by Sir Charles Parsons.

There are those who hold that how posterity will provide itself with supplies of energy is posterity's own concern and need cause us no uneasiness; the gas industry takes a wider view. Its processes are continually being examined with a view to effecting greater conservation of coal. In a Report to the Institution of Gas Engineers in 1919, by Sir Dugald Clerk, Profs. Cobb and Smithells, it is shown that the thermal efficiency of the process of carbonisation of coal achieved to-day in the United Kingdom is from 70 to 80 per cent., and that debiting gas with the whole of the thermal losses of the process and allowing for transmission and other losses, at least 45 per cent. of the heat of the coal carbonised is delivered to the consumer as inflammable gas. This is a high figure, but it can be considerably improved upon if the heat content of the coke produced, amounting to more than 10 cwt. per ton of coal carbonised, is made available to the consumer by the conversion of the coke into gas. The Gas Regulation Act, 1920, had this point among others in view when it conferred upon individual gas undertakings freedom to declare the calorific value of the gas each would supply. As there appears to be considerable confusion of thought on this matter, perhaps it were as well if we explained briefly the nature of the component mixtures constituting towns' gas.

> "We see all sights from Pole to Pole,
> And glance and nod and bustle by,
> And never once possess our soul,
> Before we die."

Blue water gas is produced from coke by passing air and steam alternately over an incandescent bed of this fuel. Its calorific value is about 300 B.Th.U. per cubic foot, and its composition is approximately represented by CO_2, 4·5 per cent.; CO, 43 per cent.; H_2, 48 per cent.; methane, 0·5 per cent., and nitrogen, 4 per cent. Sometimes this gas is mixed direct with coal gas in a towns' gas supply, a customary proportion being 80 per cent. of coal gas and 20 per cent. of water gas, the percentage of carbon monoxide in the resulting mixture being approximately 14 per cent. and the resulting calorific value about 500 B.Th.U. per cubic foot. More commonly, however, carburetted water gas, produced by enriching blue water gas with gaseous hydrocarbons derived by "cracking" various oils at high temperatures, is used for this purpose. The carbon monoxide content of carburetted water gas is on the average about 27 per cent., and, when admixed to the extent of about 20 per cent. with straight coal gas, a mixture containing approximately 11 per cent of carbon monoxide results. Straight coal gas produced by the high temperature distillation of coal has a calorific value of about 560 B.Th.U. per cubic foot and contains about 7 per cent. of carbon monoxide.

The thermal and chemical efficiencies of manufacture of different grades of gas by various processes have been the subject of three reports by a Joint Committee of the University of Leeds and the Institution of Gas Engineers. The first Report dealt with the process of steaming the charge in continuous vertical retorts, and the results showed that the thermal efficiency of gas production increased from 54·5 per cent. without steam to a maximum of 62·1 per cent. with moderate steaming, and at the same time increased yields of tar and ammonia were obtained. These results were later confirmed by work carried out about the same time by the Fuel Research Board. The second Report showed that the efficiency of production of blue water gas as ordinarily practised in a plant without waste heat boilers, taking into account the steam required for the operation of the plant, averaged 46 per cent. In the third Report on the subject (contained in the Committee's Seventh Report, a copy of which has just been received, presented to the Institution of Gas Engineers in June 1922), the Committee shows that the percentage thermal efficiency of production of carburetted water gas of calorific value about 485 B.Th.U. per cubic foot, taking into account all steam required, was increased from 59·5 per cent to 68 per cent., by the use of waste heat boilers employed for steam raising by means of waste heat in the flue gases. The efficiency of production of blue water gas was 53 per cent. and of the production of gas from oil for carburetting 90 per cent. The percentage thermal efficiency of the waste heat boilers averaged only about 46 per cent.

The problem foremost in the mind of the gas industry to-day is the production and distribution of the Therm at the cheapest price. The maximum conservation of coal within the industry will be achieved when that problem has been settled. While the Fuel Research Board could not, from the nature of the problem, specify any one grade of towns' gas as being under all conditions most suitable for production and distribution, its recommendations, embodied in the Gas Regulation Act, 1920, do, for the first time in the history of the industry, enable the relative efficiencies of gas production by various processes and in different parts of the kingdom to be compared on a scientific basis. The work of the Committee to which reference is here made is evidence of the quickened interest on the part of the gas industry in these matters and an earnest of higher efficiencies yet to be realised, and a cheaper Therm still to be distributed.

J. S. G. T.

Optical Works of Messrs. Adam Hilger, Ltd.

THE show-rooms of Messrs. Adam Hilger, Ltd., 75A Camden Road, London, N.W.1, contain a very interesting exhibition of optical instruments, to the inspection of which visitors are cordially invited. A short account of some of the devices and operations seen during a recent visit to the works may be of interest to readers of NATURE.

In a room devoted to the grinding and polishing of lenses and mirrors, a recently silvered mirror was being coated with a thin varnish to preserve the surface of the film which was not in contact with the glass, and was to be used to reflect light in an optical instrument in the same way that a silvered mirror is used in an astronomical telescope. The mirror was circular and about 4 inches in diameter, cathodically silvered. It was mounted by soft wax on a wooden mandril which revolved on a vertical shaft at some thousand revolutions per minute with its silvered surface uppermost. Dust was brushed from the surface by means of a fine camel's hair brush, and then a weak solution of celluloid in amyl acetate was poured upon it and left to dry, while the mirror was rapidly revolving. This left a thin film of celluloid on the mirror, which preserves its brightness. Films which are thick compared with a wave-length of light protect the silvered surface almost indefinitely, but these do not allow of the highest definition. On the other hand, films which are thin compared with a wave-length of light do not preserve the silver so well, but do not, however, in any way adversely affect the optical performance of the mirror. Films of intermediate thickness would tend to produce colours on the principle of Newton's rings.

Several prisms of rock salt were seen in process of manufacture; these cannot be ground with water as in the case of glass, owing to its dissolving action on the substance, so paraffin is used instead, and the accuracy of the rough grinding is tested by steel sets of 60° angle. All finished optical surfaces are, of course, tested by interference methods, the source of light being the mercury vapour arc. A Lummer plate was being tested by this means. Newton's rings were used, and they were plainly visible in spite of the thickness of the plate.

In another room the thickness of a piece of plain parallel quartz some $1\frac{1}{4}$ in. × $1\frac{1}{4}$ in. × $\frac{1}{8}$ in. was being measured on a Michelson interferometer. The half-coating of silver had been removed from one of the mirrors of the instrument, and the specimen was then "contacted on" to this mirror so as to cover one half of it. The whole was then half silvered, and the distance between the two surfaces was measured in air. What appeared to be a slight scratch in the centre of the specimen was in reality a slit in the glass, of width only 16 wave-lengths of light (λ5461). This slit was made in the manner illustrated in the accompanying diagram (Fig. 1). It will be seen that the quartz plate was in reality built up of four pieces, all optically finished with extreme accuracy. Starting with 1, 2 and 3 were contacted on and heated sufficiently to make these three join up into one piece, but, of course, not too much, or the optical perfection of the surfaces would be spoilt. The protruding edges of 2 and 3 where they meet 4 were then ground and polished so that they extended beyond 1 a distance equal only to 16 wave-lengths. This distance was measured with the Michelson interferometer, and then 4 was contacted on and the heating process repeated.

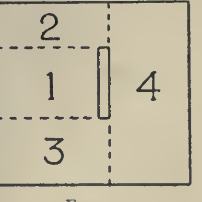


FIG. 1.

In the workshops an accurate screw was being cut similar to that which is used in the Fabry and Perot interferometer. This was done on an automatic electrically controlled lathe. Whenever the cutting tool reached the end of its stroke, electrical contacts were made, which moved the tool away and brought it back to the beginning of the next cut. The screw, when turned, is rotated from end to end through a long split nut, driven by an electric motor with an automatic reversing gear. The nut contains a thermometer, the temperature of which is read from time to time to avoid over-heating, and this is apparently sufficient for the purpose, though one might have thought that an oil-bath would have kept the temperature more constant. Great care has to be

taken with the end thrust bearing of this screw, so that no periodic error may occur when it is in the instrument. To ensure this, the end of the screw has a small flat surface optically ground and polished. This rests against a ruby plate to take the end thrust of the screw. The plate is capable of adjustment, and there will be no periodic error when the system of interference fringes which can be observed between the ruby plate and the end of the screw remain unchanged while the screw is revolved. The screw is said to be true to 1/100,000 mm.

Among other things seen were the testing of a camera lens for non-axial rays by the interference method recently perfected by Mr. Twyman, and fully described by him in one of the catalogues and elsewhere,[1] and some extremely delicate thermo-junctions for spectro-bolometric work.

Mr. Twyman states that the large majority of those who come to inspect Hilger's showrooms, or apply to be shown over the works, are foreigners, and it is with the hope of bringing this exhibition to the knowledge of British men and women who are interested in optical design and spectrographic work in general, that the foregoing has been written.

C. C. L. GREGORY.

1 "An Interferometer for testing Camera Lenses." Read before the Optical Society, April 14, 1921

Biometry and Mathematical Statistics.

IN the new double number of *Biometrika* (vol. 14, Parts 3 and 4, Cambridge University Press. Price 30s. net) ample evidence is provided to show how groundless is the charge that the interest of modern statistical work is wholly mathematical. Of the ten memoirs published, only three require for their intelligent perusal more than a very moderate knowledge of algebra. The three mainly mathematical papers are Mr. Egon Pearson's evaluation of the probable error of a Class-index correlation, Prof. Pearson and Miss Elderton's paper on the Variate-difference method of determining correlation —a valuable contribution to the controversy which has arisen over the applicability of this method to various kinds of data—and Mr. E. C. Rhodes' paper on a particular type of Skew Correlation surface.

The most important of the biometric papers is Mr. Morant's careful study of the Tibetan skull. Mr. Morant concludes that there are in Tibet at least two distinct races—one closely allied to the Southern Chinese, Malayans, and Burmese, the other not showing any close affinity to any other oriental race, but resembling most the Burmese B and C types. He conjectures that he may here be dealing with widely scattered fragments of a fundamental primitive human type, with a long-headed, broad-faced, rugous and massive cranium.

Dr. Lucy Cripps, Dr. Major Greenwood, and Miss E. M. Newbold contribute a study of the inter-relations of "vital capacity," stature, stem length, and weight, based upon data furnished by the medical department of the Royal Air Force. They conclude that, so far as these data are concerned, Prof. Dreyer's modifications of Hutchinson's methods, in particular the substitution of stem length for height, are not marked improvements. Miss Elderton's memoir on the present position with regard to the inheritance of intelligence concludes with the words: "To each of us a limit is set, a limit, as far as one can see at present, due to heredity rather than to opportunity, and to the intelligence of our parents and ancestors rather than to the educational system under which we were reared."

Dr. Percy Stocks describes—giving a pedigree—a facial spasm inherited through four generations. Two other papers—one a short addendum to a memoir on the sesamoids of the knee-joint, the other on a digital anomaly—are of medical interest. Dr. G. D. Maynard discusses the fertility statistics of the New Zealand census. The *miscellanea* contain two notes on points of method and reviews of two recent contributions to mathematical statistics.

There must be very few students of pure or applied statistics who will fail to find anything of interest to them in this issue of *Biometrika*.

Glacial Deposits and Palæolithic Cultures in East Anglia.

AT a meeting of the Royal Anthropological Institute held on June 19, Mr. H. J. E. Peake in the chair, Prof. P. G. H. Boswell and Mr. J. Reid Moir presented a paper on "Flint Implements at Foxhall Road, Ipswich." Prof. P. G. H. Boswell dealt with the geology of the deposits. The site lies in an oval hollow about 120 ft. above Ordnance datum, 1¼ miles E.N.E. of Ipswich station. The surrounding plateau of glacial sand and gravel lies at about 130 to 140 ft. above Ordnance datum. The succession of general sequence of deposits from bottom to top down to a depth of 31 ft. 4 in. is as follows: Dark Chalky-Kimmeridgic Boulder Clay (bored to 2 ft. 6 in.), loamy sand and shingle (6 ft. 9 in.), sandy boulder clay and loam (3 ft.), gravelly and sandy brick-earths passing up into laminated brick-earths (15 ft. 3 in.), gravel and subsoils, etc. (3 ft. 10 in.). Mechanical analyses of the respective beds have been made, and as a result suggestions were offered regarding conditions of deposition. The mineralogical characters have also been worked out, the assemblage being of typically glacial character. Reasons for referring the lowermost deposits to the Chalky-Kimmeridgic Boulder Clay were given, and the evidence that the uppermost gravel indicated a recrudescence of cold or even glacial conditions after a period of amelioration were discussed. Finally, tentative correlations with the glacial sequence in Lincolnshire and Yorkshire were attempted.

Mr. J. Reid Moir described the implements found in the excavations. The number of humanly-flaked flints totals 545: the latest artefacts in Beds Nos. 2 and 3 being referable to the Mousterian epoch; the unrolled hand-axes of Beds Nos. 4 to 6 are of late Acheulean date; while those recovered from Bed No. 7 appear to represent examples of early Acheulean workmanship. Associated with the well-finished implements in the beds mentioned were found a number of simply-made artefacts, such as scrapers, points, and borers. Burnt flints were also recovered from each implementiferous horizon; while quartzite hammer-stones occurred in Bed No. 7. With the exception of one small and unidentifiable piece of bone, no organic remains were found during the excavations. An examination of the artefacts recovered shows that the specimens were flaked differently at the different horizons mentioned, and that a large proportion of the flints are considerably striated; the pressure to which

the specimens have been subjected has not, so far as can be seen, resulted in the removal of flakes. Several rostro-carinates—representing partly finished hand-axes—were found in the Acheulean strata.

In the discussion which followed the paper, Prof. W. J. Sollas said that we now have convincing evidence that the greater part of the Mousterian was glacial, and late glacial—Würm—at that. It is possible that the earlier Mousterian implements of the type of La Micoque belong to the interglacial Riss-Würm. The Upper Acheulean implements found at the top of the lower loess must therefore be referred to the Riss glaciation. There are difficulties, however, and while it might be expected that something intervened between Acheulean and Mousterian, there is no evidence that anything did. Mr. Bury pointed out that while on this site there is a separation between Chelles and Acheulean types, such separation does not occur in the gravels south of the Thames. Curiously, the site also shows a gradual climatic change working up from Acheulean to Mousterian, while south of the Thames the implements occur at different levels—the Acheulean at 100 to 150 ft., and the Mousterian, if occurring in gravels at all, at lower levels. It was this apparently to which Prof. Sollas referred.

Mr. Peake said that this investigation appears to clear up the difference between monoglacialists and polyglacialists. One point, however, has not been cleared up, and that is the relative position of the different industries. On the Continent it is generally held that the Mousterian equated with the Würm, but in America Prof. Osborne at least appears to have abandoned this position. The question arises, which of the four glaciations recognised on the Continent equate with the three glaciations for which there is evidence here? Prof. Boule has maintained that he is unable to find marked evidence for the Gunz glaciation in Western France. This suggests that the centre of glaciation was farther east, and that similar conditions prevailed in this country. In this case our three glaciations would equate with the three later of the Continental glaciations.

University and Educational Intelligence.

LEEDS.—One of the most important departments of the University is that which deals with agriculture, for, while the University is situated in a great industrial city, it is also the centre of the largest agricultural county in England. A new building for the department is about to be commenced. This has been made possible by the generous help received by the University from several sources. The late Mr. Walter Morrison gave a sum of 10,000*l*., a donation which, by his wish, remained anonymous during his lifetime; a Treasury grant through the Ministry of Agriculture and Fisheries of 12,000*l*., promised in 1914, has been increased to 15,000*l*.; the Yorkshire Council for Agricultural Education has contributed approximately 10,000*l*.; and there have been numerous other donations. The University is providing the site and the balance of the money required. The building will be located in University Road, west of the buildings of the Textile (Clothworkers) group, and will occupy a plot 190 feet long by 125 feet deep.

LONDON.—The following doctorates have been awarded, the subject of the thesis presented appearing after the name:

Ph.D. (*Science*):—H. E. M. Barlow (University College): "An Investigation of the Friction between Sliding Surfaces, with special reference to the Effects produced by Electric Currents passing across such Surfaces"; Miss F. E. Barnett (Northern Polytechnic Institute): "Some Problems of the Endodermis—The Distribution of the Endodermis in Angiosperms, with some Observations on the Function of the Endodermis"; W. A. P. Challenor (Imperial College, Royal College of Science): "Conditions underlying Carbon Ring Formation"; B. W. Clack (Birkbeck College): "A Research on Diffusion in Liquids"; P. W. Cunliffe (King's College): "(*a*) Studies in Photo-Chemical Light Sources; (*b*) Studies on the Photolysis of Aqueous Solutions of Hypochlorous Acid and of Chlorine"; F. Dickens (Imperial College, Royal College of Science): "The Conditions of Formation of Four- and Five-membered Rings from Substituted and Unsubstituted Open Carbon Chains"; Miss C. H. Griffiths (Birkbeck College): "(1) Diffraction Patterns in the presence of Spherical Aberration; (2) Co-efficients of Diffusion of Potassium Chloride, Sodium Chloride, and Potassium Nitrate determined from the published experimental data of Mr. B. W. Clack by a method due to Dr. Albert Griffiths"; A. A. S. El Kirdany (Imperial College, Royal College of Science): "The Calculation of the Motion of an Inviscid Fluid round an Aerofoil when Cyclicity is assumed to be present"; Miss I. E. Knaggs (Imperial College, Royal College of Science): "The Relation between the Crystal Structure and Constitution of Carbon Compounds, with special reference to simple Substitution Products of Methane"; K. C. Pandya (Imperial College, Royal College of Science): "The Influence of Groups on Cärbon Valency Direction"; H. A. Piggott (Imperial College, Royal College of Science): "A Study of the Conditions which determine the Mobility (or otherwise) of certain Potential Tautomeric Systems of the Glutaconic Acid Type in the Aromatic Series"; H. H. Potter (King's College): "Some Experiments on the Proportionality of Mass and Weight"; L. Rebekoff (King's College): "(*a*) Studies in the Photolyses of Formic and Oxalic Acids; (*b*) Studies in some Photochemical Light Sources"; D. O. Shiels (King's College): "The Adsorption of Water Vapour and other Vapours by Charcoal"; B. Singh (Imperial College, Royal College of Science): "Formation and Stability of Cyclic Compounds derived from B Substituted Glutaric Acid"; I. W. Wark (University College): "Some Copper Complexes with Hydroxy-Acids"; A. F. A. Young (King's College): "The Thermionic and Photo-Electric Properties of the Electro-positive Metals"; F. Arnall (Chelsea Polytechnic): "Studies in the Nitration of Phenol"; G. R. Clemo (Queen's College, Oxford): "The Introduction of the B-chloro-ethyl Group into Phenols, Thio-phenols, Aromatic Amines, etc."; J. W. Cook (Sir John Cass Technical Institute): "Some Derivatives of Anthracene"; B. S. Evans: "An Investigation into the Chemistry of the Reinsch Test for Arsenic and Antimony, and its Extension to Bismuth"; P. T. Freeman: "On the Binaural Location of a Source of Sound of Low Frequency, and its Application"; S. I. Levy: (1) "Studies on Cyclic Ketones, Parts II. and III."; (2) "An Attempt to resolve an Oxonium Salt"; (3) "The Action of Amino-Acid Esters on Ethyl Dicarboxyglutaconate"; (4) "(4'-Methoxy-1'-naphthyl)-2-chromon"; A. H. Stuart: "The Problem of securing Rigidity in an Aeroplane Wing"; and C. L. Withycombe (Imperial College, Royal College of Science): "Neuroptera, their Biology and Anatomy."

APPLICATIONS are invited for the Drapers' Company's research scholarship in dyeing at the Technical College, Huddersfield. The scholarship includes re-

mission of fees, together with a maintenance grant of 100*l*. per year. Further particulars and forms of application may be obtained from the Secretary of the College.

A REPORT on "Health for School Children" prepared by the National Child Health Council's advisory committee on health education has been published by the United States Bureau of Education as School Health Studies No. 1. Its keynote is given in the following words: "It is essential that health shall not be regarded as an isolated subject. . . . Health motives and practices should permeate the whole school life and work. Methods of teaching health, of illustrating health, and of living health cannot be torn out or set apart from the child's life, but should be woven into its very fabric." It follows that all elementary-school teachers must be indoctrinated with proper health ideals and principles and inspired with an active appreciation of their importance; and likewise that the active co-operation of parents must be sought. Normal schools must give all students a grounding in general science (chemistry, physiology, bacteriology, and biology), personal hygiene, community and social hygiene, and nutrition, including fundamental instruction regarding foods and normal growth; but even more essential than instruction in these subjects is attention to the health of the students themselves, for "better far a young teacher thoroughly well and with some enthusiasm for health and no methods, than one who is even a little neurotic, a trifle hollow-chested, but method-perfect." In summer sessions normal schools should make health courses obligatory. The committee is considering the publication of a bibliography.

"PHILANTHROPY in the history of American higher education" is the subject of a bulletin (1922, No. 26) of the United States Bureau of Education prepared by Prof. Sears, of Stanford University, California. The writer, summing up the results of his researches, observes that although the "dead hand" may be said to rest in some degree upon most of the institutions of higher education, their vitality is not appreciably affected thereby. This is attributed partly to colleges and universities refusing gifts to which undesirable conditions are attached, and partly to the good sense generally evinced by benefactors. A description is given of a new type of foundation which is said to be coming rapidly into favour. It combines some of the characteristics of a joint-stock company with those of a public trustee. The Cleveland Foundation, the first of this type, has for its object "the mental, moral, and physical improvement of the inhabitants of the city." It receives gifts and bequests, however small, and whether accompanied by any expression of wishes as to their disposition or not, but undertakes to respect such wishes only in so far as shall seem to the board of directors wise and beneficial. The members of the administrative committee are appointed partly by the mayor, the judge of the probate court, and the federal district judge, and partly by the trustee company which manages the principal as a single trust. Prof. Sears does not allude to the injurious effects on college administration of the habit of looking to philanthropists for gifts, yet it is notorious that college presidents have sometimes been chosen mainly on the ground of their supposed efficiency as soliciting agents; nor does he mention the all-important consequence of so-called benefactions—that they must, in the end, to use the words of another writer on this subject, "involve a personal responsibility and a personal scrutiny: somebody must sweat blood with gift money if its effect is not to do more harm than good."

Societies and Academies.

PARIS.

Academy of Sciences, July 16.—M. Albin Haller in the chair.—L. C. **Jackson** and H. **Kamerlingh Onnes**: The magnetic properties of gadolinum ethylsulphate at low temperatures. The determination of the magnetic susceptibility of the powdered salt at temperatures ranging between 14°·56 K. (the lowest temperature obtainable with liquid hydrogen) and 291°·5 K., showed that gadolinum ethylsulphate obeys Curie's law, the product of the molecular susceptibility and the absolute temperature was constant. A single large crystal, the salt, although crystallising in the hexagonal system, was found to be magnetically isotropic.—J. B. **Senderens** and J. **Aboulenc**: The catalytic preparation of the aminocyclohexanols. Para- and ortho-nitrophenol are reduced by hydrogen under pressure (50 atmospheres) in the presence of nickel as catalyst. The reduction takes places in stages; at 90° C. aminophenol is produced, but if the temperature is raised to 180° C., additional hydrogen absorption occurs and aminocyclohexanol is obtained.—Charles **Nicolle** and E. **Conseil**: New facts concerning measles. Preventive vaccination. Conditions of contagion. The serum of convalescents confers a temporary immunity from infection: serovaccination, an injection of serum from a convalescent, followed 24 hours later by injection of blood from a patient with measles, confers a longer immunity. Contrary to the accepted view, the author maintains that one attack of measles does not confer permanent immunity, but a recurrence of the disease may be so mild (a rise of temperature only without eruption) that the nature of the disease on the second attack may escape recognition.—Philip **Fox**: Measurements of stellar parallax at the Dearborn Observatory. Data for 31 stars are given; each figure is derived from measurements of from 11 to 21 photographs.—M. **Holweck**: A high-power lamp for wireless telegraphy with removable parts. Diagram and description of a triode lamp of 10 kilowatt type now in use for postal service at the Eiffel Tower station. The lamp can be taken to pieces, the joints being either rubber or ground glass. For maintaining the vacuum, the lamp is permanently connected with the helicoidal molecular pump, described in an earlier communication (*Comptes rendus*, 177, p. 43).—A. **Dauvillier**: An experimental verification of the theory of Röntgen ray spectra due to a multiple atomic ionisation.—Pierre **Auger**: The secondary β-rays produced in a gas by the X-rays. By a modification of C. T. R. Wilson's method, taking simultaneous photographs in two perpendicular directions, information has been obtained about the trajectories of the electrons torn from the atoms of a gas by a bundle of X-rays.—M. **Escher**: The polonium carried down with bismuth hydrate in soda solution. When an acid solution containing bismuth and polonium is precipitated with soda, the polonium is distributed between the precipitate and the solution. The distribution of the polonium between the two phases is a function of the number of molecules of bismuth and of soda present in a given volume of the mixture. Two sets of experimental results are given in graphical form.—N. **Yannakis**: The vapour pressures of mixtures of hydrochloric acid and water.—P. Mondain **Monval**: The allotropic transformation of ammonium nitrate at 32° C. From the law of solubility given by Le Chatelier, it follows that two varieties of the same salt having different latent heats of solution should have different solubility curves, and at their point of

intersection, the two curves having different directions, should show an angular point. Determinations of the solubility of ammonium nitrate at eleven temperatures between 26·7° and 39·2° C. and calorimetric experiments on the same salt at 28° C. and 36° C. give results confirming the views of Le Chatelier.—P. **Laffitte**: The propagation of the explosive wave. A study by the photographic method of the explosion of mixtures of carbon bisulphide and oxygen in spherical glass vessels.—Mlle. **Chamié**: The ionisation produced by the hydration of quinine sulphate.—Albert **Colson**: The range of the displacement of equilibrium.—E. **Decarrière**: The catalytic oxidation of ammonia by air in contact with pure palladium. The yield of oxidised nitrogen is a function of the temperature of the catalyst, the percentage of ammonia in the gas entering, and also of the physical state of the metal. The results of experiments on the effects of the last factor are given.—André **Job** and André **Samuel**: Oxidation phenomena in the complex nickel cyanides: valence, co-ordination, coloration.—M. **Marange**: The identification of cocoa butter by miscibility curves.—M. **Haehl**: *p*-Chlorodiphenylsulphone. The chlorodiphenylsulphone prepared by Beckurts and Otto has been prepared by another method and is shown to be the para compound.—L. **Bert**: The chloride of cumylmagnesium.—Mlle. N. **Wolff**: The furfural- and difurfural-γ-methylcyclohexanones.—R. **Fosse** and A. **Hieulle**: Xanthyl-allantoin. The precipitation of this compound from an acetic acid solution serves to identify allantoin, and to precipitate it from solution containing very small proportions.—A. **Mailhe**: The preparation of petroleum starting from vegetable oils. Dry distillation of rape oil with zinc chloride gave more than 50 per cent. of hydrocarbons consisting of paraffins and unsaturated ethylene derivatives.—André **Helbronner** and Gustave **Bernstein**: The action of the antioxygens on rubber. Crude depolymerised rubber is preserved from oxidation by the presence of small proportions of antioxygens, such as tannin or hydroquinone. Vulcanised rubber thus treated does not show the usual effects of ageing.—Paul **Woog**: Direct observation of the hydration of hydrocarbons.—A. **Loubière**: A new genus of Pyrenomycetes.—Emile F. **Terroine**, R. **Bonnet**, and P. H. **Joessel**: The influence of temperature on the energy yield in germination.—A. **Polack**: The correct form of the experiment on the chromatism of the eye by the partial closing of the pupil.—R. **Faillie** and J. P. **Langlois**: The vertical oscillation of the centre of gravity of the body while walking down an inclined plane.—Mme. Anna **Drzewina** and Georges **Bohn**: The influence of light on the activating power of the sperm of the sea urchin.—Ch. **Dejean**: Rôle of the middle layer in the assemblage of the first beginnings of the eye.—P. **Lecène** and H. **Bierry**: The demonstration of the presence of sucrase in the wall of the mucoid cysts of the ovary.

CALCUTTA.

Asiatic Society of Bengal, July 4.—J. Coggin **Brown**: On the occurrence of *Ostrea gryphoides* Schlotheim in Calcutta. Specimens were found near the surface in excavations for a new building in Calcutta. They provide no new evidence on the question of a former extension of the sea over the present site of Calcutta.—H. C. **Das-Gupta**: On the fossil Pectinidæ from Hathab, Bhavanagar State (Kathiawar).—P. N. **Missra**: Lakshman Samvat. Calculation of European equivalent dates for 16 Lakhsman Samvat dates on various assumptions as to the beginning of the era.—H. C. **Ray**: Allusions to Vāsudeva Kṛishṇa Devakīputra in Vedic literature. Vāsudeva Kṛishṇa is mentioned not only in the Epic and the Purānas but also in at least two works of the Vedic literature.

CAPE TOWN.

Royal Society of South Africa, May 16.—Dr. A. Ogg, president, in the chair.—P. A. **van der Bijl**: Notes on some South African Xylarias.—A. **Ogg**: The crystalline structure of the alkaline sulphates. In conjunction with Mr. Lloyd Hopwood it was shown that the *crystal unit* of alkaline sulphates contains four molecules. With sulphur atoms at the corners and the face centres, and with the nitrogen atoms at the centres of each of the eight rhombs into which the unit can be divided by planes through the centre of the unit at right angles to one another and parallel to the faces, we can build up a structure which explains the structure of the ammonium sulphate crystal. The nitrogen atoms lie at the centre of a tetrahedron of hydrogen atoms, each hydrogen connecting up to an oxygen atom, which in turn connects up to a sulphur atom. In the structure for potassium, rubidium, and cæsium sulphates, if the metals with sulphur lie along the diagonal of the 100 face of the unit, the length of the diagonal, assuming Bragg's values for the atomic diameters, agrees with those found from X-ray measurements.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 9, No. 6, June).—L. P. **Eisenhart**: Another interpretation of the fundamental gauge-vector of Weyl's theory of relativity.—G. Y. **Rainich**: Tensor analysis without co-ordinates. A method of deriving the theory of surfaces without introducing notions having no intrinsic significance such as transformations, covariants, and contravariant quantities, the fundamental tensor g_{ij} etc.—A. B. **Coble**: Geometric aspects of the Abelian modular functions of genus four (III.).—H. D. **Curtis**: On irregularities in the velocity curves of spectroscopic binaries. The spectrographic velocity curves of some of the Cepheid variable stars seem to fit elliptical velocity curves, each with a single oscillation or hump which occurs near the time of maximum velocity of approach. This is in agreement with Duncan's theory of a large and tenuous star rotating about a darker companion in a slightly resisting medium.—W. J. **Luyten**: On the form of the distribution law of stellar velocities. The distribution and space velocities of the stars which have been observed within a sphere with the sun as centre and of radius 10 parsecs seem to fall on a simple logarithic error curve.—C. G. **Abbot** and colleagues: The solar prelude of an unusual winter. The mean monthly values of the solar constant determined at Mount Harqua Hala, Arizona, and Mount Montezuma, Chile, decreased throughout 1922 and the early part of 1923. This seems to have been related to unusual weather conditions in the United States.—C. E. **Mendenhall** and M. **Mason**: The stratified subsidence of fine particles. Suspensions of rock particles were allowed to settle in rectangular tubes across which a temperature gradient was maintained. Stratification occurred in the tubes where the amount of suspended material increases appreciably with depth, but too great a temperature gradient destroys any strata. The effect seems to be due to convection currents which circulate in definite layers.—M. **Mason** and C. E. **Mendenhall**: Theory of the settling of fine particles. An expression giving the position of layer boundaries is derived.

Experiments on two groups of tubes of suspensions show that the rate of fall of the layer boundaries is independent of the temperature gradient within wide limits, and the position of the layers is a function of concentration, time of settling, and thermal gradient.—E. H. **Hall**: The quasi-equation $P = TdV/dT$. If two plates of dissimilar metals are connected through wires made of the same metals, the plates show opposite charges. If unit charge is made to pass from the positive to the negative plate, heat is absorbed; this includes the Peltier effect at the junction. Assuming a mass-law of equilibrium between the ions and electrons of the metals, heat-energy is absorbed at the free surface of the metals in addition. This added to the Peltier effect gives nearer accordance with experimental results.—E. F. **Nichols** and J. D. **Tear**: Joining the infra-red and electric wave spectra. A Hertzian doublet with minute platinum cylinders acted as the source of the waves. The receiver consisted of a Nichols radiometer in which the vanes were mica strips carrying thin deposits of bright platinum. A new form of reflecting echelon analyser was used for the wave-length measurements. By these means electric waves of lengths varying from 7 mm. to 0·220 mm. were produced and detected, thus overlapping previous measurements for infra-red radiation (*e.g.* Rubens and Von Baeyer, 0·320 mm.).

(Proc. Vol. 9, No. 7, July).—A. E. **Kennelly**: On the constant ratio of mean-to-mid potential or current at successive equidistant points along a uniform electric conducting line, real or artificial, in the steady state. The theorem also applies to tables of hyperbolic sine or cosine functions where the angle increases in uniform arithmetical progression, and to tables of $\epsilon^{\pm\theta}$ where θ increases in uniform arithmetical progression.—R. **Brown**: Some recent measurements of transatlantic radio transmission. A high-power vacuum tube transmitter with an output of 200–300 amperes of 57,000 cycle alternating current is used at Rocky Point, Long Island, producing continuous radiation of about 5250 metres wave-length. A receiver in London evaluates the absolute root mean square of the electric field produced. The field rises sharply to a maximum during the period when the route is in darkness, but does not exceed the value calculated from the Austin-Cohen radio-transmission formula. Good night transmission seems to be due to a diminution of losses by absorption rather than to focussing effects.—C. B. **Davenport**: Body build and its inheritance. The ratio, chest girth to stature, or alternatively weight to stature, was used as an index of build in man. A solid figure generated by combining the variability curves with developmental curves shows two main ridges, indicating two main types, medium build and fleshy; the latter seems to refer to the progeny of fleshy and slender strains, showing dominance of fleshiness.—G. C. **Evans**: A Bohr-Langmuir transformation. Mathematically, Langmuir's completely static atom can apparently be shown to be equivalent to the Bohr atom with a circular orbit.—G. A. **Miller**: Form of the number of the subgroups of a prime power number.—G. **Breit**: (1) The interference of light and the quantum theory. Assuming that radiation momenta are transferred in quanta, expressions are derived which represent the effect of (*a*) a diffraction grating of infinite width, (*b*) a finite number of narrow, parallel, co-planar and equal slits, and (*c*) a slit of finite width. (2) Note on the width of spectral lines due to collision and quantum theory. The amounts of the broadening appear to be nearly equal to those given on the wave theory of light and can be accounted for similarly.—P. A. **Ross**: Change in wave-length by scattering. Experiments were made to detect the change in frequency of X-rays and γ-rays on scattering by paraffin, aluminium, and graphite suspected by Compton. Relevant equations indicate that the change of wave-length is independent of the primary wave-length. No such shift was observed by scattering the green mercury line at 180° from paraffin. Using photographic methods and X-rays, the required displacement (about 0·025 Å.) was observed by scattering the α_1 and α_2 lines from calcite at 90° from paraffin. Another unshifted line was recorded.—E. L. **Nichols**: Notes on germanium oxide. The powdered oxide was heated, side by side with a uranium oxide surface, in an oxyhydrogen flame. The radiation of uranium oxide being practically equivalent to black-body radiation, a comparison of the two gives approximately the radiation of germanium oxide in terms of black-body radiation. Preponderance of blue at lower temperatures and of red near fusing point are the characteristics. The reversal point is 1225° C. and melting point 1400° C.—C. **Wissler**: The correlation of respiratory and circulatory data for adult males. Pulse rates in men before and after exercise show a high correlation (+0·73); pulse rate correlates with respiration rate (+0·45) but not with blood pressure and chest mobility. Breathing rate and chest mobility appear to be complementary (correlation −0·46), *i.e.* a man with a mobile chest automatically breathes deeply.—T. W. **Vaughan**: Studies of the larger tertiary foraminifera from tropical and subtropical America. There appears to be no evidence of deposits of Lower Cretaceous age at relatively shallow depths in Florida. Deposits of middle and upper Oligocene age occur in northern Colombia. An evolutionary sequence from ancient Eocene forms of Lepidocyclina with meridional chambers, pointed inner ends, and curved outer walls, to species with hexagonal and rhomboid chambers, is suggested.—S. O. **Mast**: Mechanics of locomotion in Amœba. Three regions are differentiated in *Amœba proteus*: (*a*) a central elongated fluid portion (plasmasol); (*b*) a granular layer surrounding the fluid (plasmagel), and (*c*) a thin elastic surface membrane (plasmalemma); (*b*) and (*c*) are semipermeable and (*a*) is hypertonic. Local swelling of the plasmagel occurs at the tip of pseudopodia with liquefaction on the inner surface at the posterior end. Gelation of plasmasol occurs at the outer posterior border of the swelling. Thus a forward flow is produced which is translated into motion by the adhesion of the plasmalemma to the substratum.

Official Publications Received.

Western Australia. Annual Progress Report of the Geological Survey for the Year 1922. Pp. 12. (Perth: F. W. Simpson.)

Department of the Interior: Bureau of Education. Bulletin, 1922, No. 42: Analytic Survey of State Courses of Study for Rural Elementary Schools. By Prof. Charles M. Reinoehl. Pp. v+116. 20 cents. Bulletin, 1923, No. 1: Diagnosis and Treatment of young School Failures. By Helen Thompson Woolley and Elizabeth Ferris. Pp. vi+115. 10 cents. Bulletin, 1923, No. 18: Medical Education, 1920–1922. By Dr. N. P. Colwell. Pp. 17. 5 cents. (Washington: Government Printing Office.)

University of Cambridge: Solar Physics Observatory. Tenth Annual Report of the Director of the Solar Physics Observatory to the Solar Physics Committee, April 1, 1922–March 31, 1923. Pp. 8. (Cambridge.)

Department of Commerce: Technologic Papers of the Bureau of Standards. No. 237: Aeronautic Instruments. By Franklin L. Hunt. Pp. 447-511. (Washington: Government Printing Office.) 20 cents.

Journal and Proceedings of the Asiatic Society of Bengal. New Series, Vol. 18, 1922. No. 6: Proceedings of the Ninth Indian Science Congress. Pp. xi+197. (Calcutta: Asiatic Society.) 13 units.

The Rockefeller Foundation. A Review for 1922: a Summary for the First Decade. By George E. Vincent. Pp. 59. (New York.)

SATURDAY, AUGUST 18, 1923.

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The Helicopter: is it worth a Prize?

JULES VERNE is responsible for the idea of the helicopter, and as a writer of works of imagination he invented devices with ease. The aeronautical engineer asked to produce a helicopter must recognise some limitations of his powers, and one is led to wonder whether the author of "The Clipper of the Clouds" could have solved the problems associated with the materialisation of his ideas. Press comments on the official conditions for the test of a helicopter, and the wording of the rules by the Air Ministry, raise the principle involved in this idea in a form of considerable interest to men of science. In the *Times* of May 11 appeared the following paragraph:

"Still, the Air Ministry cannot afford to neglect the possibility that some practical helicopter may suddenly be evolved, and by their action they have made reasonably sure that any such development will come before their notice."

To guard against the possibility of ignorance in this particular direction, prizes to the total value of 50,000*l.* have been offered; the cost of the aeronautical research at the National Physical Laboratory is about 23,000*l.* per annum. The construction of the Brennan helicopter by the Air Ministry at Farnborough is variously estimated to have cost from 60,000*l.* to 100,000*l.*; lack of separate accounts for research and *ad hoc* experiments make it difficult to estimate the cost of scientific research at Farnborough, but it is probably of the same order as that at the National Physical Laboratory. It is believed to be inadequate for systematic progress on the full scale, with the result that Britain is far less active than America.[1]

Is the Air Ministry in danger of losing the substance for the shadow in giving prominence to a policy based on accidental strokes of genius rather than on patient and certain inquiry? Scientific workers at least will realise how foreign such a policy is to their own work.

Leaving this issue, which needs no elaboration in the columns of NATURE, it is interesting to examine the prize scheme on technical grounds. A passage which crystallises the underlying idea says: ". . . . a successful helicopter—that is, a machine capable of rising vertically from the ground under its own power, . . ." thereby indicating the property to which chief importance is attached as that which allows an aircraft to leave the ground and return to it without the high forward velocities of 50-60 miles per hour normal to the aeroplane. Such a property added to an aeroplane would be welcomed by all

[1] See the Wilbur Wright memorial lecture before the Royal Aeronautical Society by Dr. Ames, Chairman of the Executive Committee of the American National Advisory Committee for Aeronautics (1923).

interested in flying, but technical opinion, as voiced in public discussions, considers that in attaining this feature by the helicopter almost every other desirable quality of a flying machine is sacrificed.

Criticism has turned largely on the lack of efficiency and safety in the helicopter. The airscrew is not a new device and the principles of its operation are well established; efficiencies of 75 per cent. can be reached and utilised in the aeroplane *because it is an aeroplane*. This point is of some interest and merits further study; all heavier-than-aircraft are supported during flight on the sacrificial principle, that is, something else is driven down to keep the aeroplane from falling under the influence of gravity. In the aeroplane the utilisation of power in producing lift is indirect, for the airscrew is made to overcome the resistance of the aeroplane, whilst the wings produce the down current, and by reaction, the lift. This lift may be nine times as great as the thrust of the screw, and is rarely less than three times its amount.

The arrangement is efficient because the wings are large organs; it is the momentum generated per second which produces lift, whilst the power required is roughly measured by the energy thrown away in the downwardly moving air. The loss of energy for a given lift decreases progressively as the area of the downward stream is increased, and hence the efficiency of the aeroplane follows, in part, from the use of large wings. If the helicopter is to compete with the aeroplane on the score of efficiency its lifting screws must be large.

As the extreme case of large size, consider two aeroplanes flying in a circle and connected by some framework at present undefined, except that it supports a car at its centre. A first problem is immediately indicated—means must be provided for keeping the car free from rotation. If the aeroplanes are far enough apart their efficiency will remain as before, and as supporters of weight are fully effective. As a means of getting from place to place the combination is, of course, useless; modification of the problem still leaves us with the obvious conclusion that, whereas the wings of an aeroplane travel directly from point to point, those of the helicopter follow sinuous and longer paths. The argument seems to be fundamental and to exclude the helicopter from the degree of efficiency as a means of transport which can be reached with a good aeroplane.

Returning to our example, it will be found that a new factor enters into the problem as the two aeroplanes fly in smaller and smaller circles; each passes through the downwash produced by the other and by itself on previous passages. If near enough, this interference becomes very important, and it constitutes the only real difference between the helicopter as hitherto projected and the airscrew as commonly used. In looping, pilots frequently feel a bump on closing the loop, although some fifteen seconds has elapsed since the first passage and the distance travelled has been about 1000 ft. A further illustration explained on this principle arises from the observation that an increase of thrust arises from the sideways moving of a stationary airscrew, and therefore may be expected in a helicopter when used for transport.

All this is known, and the principles were laid down many years ago by the late Lord Rayleigh and others. Combined with modern data, it is possible to use existing knowledge to predict the limits of efficiency of a helicopter and to rely on the results. The design of the structure which holds the wings together presents greater difficulties, and attempts to build helicopters now may react favourably on structural design, but probably at a cost far in excess of that required to produce the same results by research.

Most of the attempts at helicopter design have led to screws some 40 to 60 ft. in diameter moving on the periphery at speeds of 70 to 100 m.p.h. Devices produced in more than one country have lifted themselves into the air, but little has been attempted in free flight. The Air Ministry has announced the development of the Brennan helicopter to the stage of lifting itself, and only ten per cent. of the prize money is allocated to the extension of this performance from a few feet to vertical flight up to 2000 ft. in a light breeze.

The rest of the competition relates to transport and control. One particularly hazardous requirement is that the helicopter ". . . must descend vertically from a height of not less than 500 ft. without engine. . . ." It is a crucial test which, I believe, would involve certain death to the pilot who attempted it in the helicopters so far devised. In the case of engine failure, the helicopter at best is less effective than a parachute having an area equal to its blade surface, and is quite unable to provide an adequately small rate of descent. At its worst it is far inferior to this. In all circumstances the aircraft will require control, and the solutions hitherto proposed do not inspire confidence. It is evident that even the essential principles of a happy solution depend on that stroke of genius for which the Air Ministry is appealing and which it appears to think only needs a monetary stimulus to become operative.

Unlike the helicopter, the aeroplane does not lose its lift when the engine fails. It must perforce descend, but all its controls remain intact and danger comes only if the available alighting ground is unsuitable. Safety in aeroplanes is a subject for insistent inquiry,

but marked improvement appears to be near realisation. Safety in a helicopter presents unsolved difficulties.

What, then, is the purpose of the helicopter? Presumably the use is to be military and secret. Outside opinion has not made any satisfying guess, and in these circumstances men of science, as well as aeronautical engineers, are disturbed by the evidence which this prize scheme gives as to the direction of Air Ministry policy. It is not expected that any appreciable part of the fund will be called on, and the whole sum would not be grudged to the producers of a new and useful type of aircraft. The fear is that, in following a "will of the wisp," insufficient attention will be given to systematic research on which, in the past, British constructors have been able to maintain a high quality for their productions. L. Bairstow.

Life of a Naturalist and Teacher.

The Days of a Man: being Memories of a Naturalist, Teacher, and Minor Prophet of Democracy. By David Starr Jordan. Vol. 1: 1851–1899. Pp. xxix + 710 + 56 plates. Vol. 2: 1900–1921. Pp. xxi + 906 + 56 plates. (Yonkers-on-Hudson, N.Y.: World Book Co.; London: G. G. Harrap and Co., Ltd., 1922.) 15 dollars.

"THE Days of a Man" is the title chosen by Dr. David Starr Jordan for his autobiography. Dr. Jordan, who was born in 1851, has been for many years the leading ichthyologist in America, and is the author of a large number of memoirs on fishes, generally written in collaboration with his pupils. Of these the best known is the monumental "Fishes of North America" (1896–1900) by Jordan and Evermann, but perhaps his work on the Fishes of Japan marks the greatest advance, for these had been comparatively little studied until his collecting expedition in 1900.

Dr. Jordan's early tastes were for botany, in which he was so well-versed that even as a student at Cornell he was teaching this subject. He was first led to study fishes by attending a vacation course for science teachers organised by Louis Agassiz, and for many years afterwards he generally spent his vacations in collecting and reporting on the fishes of some region, at first on his own account and afterwards for the American Government, which ultimately sent him so far afield as the Sandwich Islands. It is perhaps worth mention that he invented the name "Rainbow Trout" in 1878.

Notwithstanding his distinction as an ichthyologist, we are inclined to think that Dr. Jordan's best work has been educational; and this applies even to ichthyology, since nearly all American ichthyologists were taught by him. In 1879, at the early age of 28, he became professor of natural history in the University of Indiana, and did so well that in 1885 he was elected president. He had now an opportunity to show his genius for organisation and to put his educational ideas into practice. There were many difficulties, but he overcame them. In his own words:

"In 1886 I made some sweeping changes, doing away with the fixed curriculum and adjusting the work so that practically all the subjects hitherto taught in the University, being elementary in their nature, were relegated to the first two years. Further than this, we instituted a 'major subject' system, by which each junior or third-year student was required to choose a speciality or 'major,' and to work under the immediate advice of his 'major professor,' whose counsel in details he was obliged to secure. An individual course of study was thus framed for each one. This system, which has now stood the test of more than thirty years in Indiana, Stanford, and elsewhere, was originally developed by a committee consisting of Dr. Hans C. G. von Jagemann, Dr. William Lowe Bryan, and myself. Its purpose was to enable every one to make the most of his four college years, by seeking the best teachers and the subjects best suited to his tastes and capacity."

Whilst carrying out these and other reforms Dr. Jordan undertook propaganda work, giving lectures that made the aims and purposes of the university understood in the State of Indiana. At the same time he showed wise judgment in making new appointments, Campbell, the botanist, and Branner, the geologist, being two of his early choices.

Jordan's success at Indiana was so great that in 1891 he was the obvious man to select as president of the newly established Stanford University. Here he had a congenial task, to plan out from the beginning the lines on which a university should be run and to select what men he liked to help him in the work. At first all went well, but in 1893 Stanford's death led to unexpected legal difficulties with regard to his estate, which seriously hampered the university, and after this matter had been satisfactorily disposed of came the earthquake of 1906, which wrecked a great part of the university buildings. On the morning of the earthquake Dr. Jordan received an invitation to become secretary of the Smithsonian Institution; in other circumstances he would probably have accepted, but he felt that it was his duty to stay at Stanford, and he did so, becoming Chancellor of the University in 1913, and finally retiring in 1916, at the age of sixty-five. He has good reason to be proud of the flourishing condition and the high reputation of Stanford, and of the success of its graduates.

Dr. Jordan is a man with high ideals and strong convictions, and he is a keen observer who has travelled in many lands. His views on men and matters are

full of interest and demand attention. He is strongly opposed to the use of alcohol and tobacco, and he regards war as an out-of-date and anti-democratic method of settling disputes. At one period he gave much attention to the reform of the American civil service, and in recent years he has devoted a great deal of his time to lectures in America, Europe, and Japan in the cause of international peace, a subject on which he has written several books. When a man's life has been so strenuous and so varied the writing of an autobiography is a task of some magnitude. But it was well worth doing, and it has been well done. We congratulate Dr. Jordan and we thank him.

C. T. R.

The Structure of the Atom.

(1) *The Structure of Atoms.* By Prof. Dr. Alfred Stock. Translated from the Second German edition by S. Sugden. Revised and enlarged. Pp. viii + 88. (London: Methuen and Co., Ltd., 1923.) 6*s*. net.

(2) *La Théorie des quanta et l'atome de Bohr.* Par Léon Brillouin. (Recueil des Conférences-Rapports de Documentation sur la Physique. Vol. 2, 1re Série, Conférences 4, 5, 6. Édité par la Société *Journal de Physique.*) Pp. 181. (Paris: Les Presses universitaires de France, 1922.) 15 francs.

(3) *Institut International de Physique Solvay.* Atomes et électrons. Rapports et discussions du Conseil de Physique tenu à Bruxelles du 1er au 6 avril 1921 sous les auspices de l'Institut International de Physique Solvay. Pp. vii + 272. (Paris: Gauthier-Villars et Cie, 1923.) 20 francs.

THE problem of the structure of the atom is one which for many years has exercised a fascination for the scientific mind. Its solution demands the correlation of phenomena from many branches of physics and chemistry, and the repercussion of the current ideas on the subject makes itself felt over a correspondingly wide field. It is a subject on which no worker in physics or chemistry dare allow his knowledge to become out-of-date, and in which other scientific workers take an interest which is by no means entirely extraneous. Owing partly perhaps to the distinction and lucidity of some of its famous exponents, it has also aroused the interest of a wider non-scientific circle and has won for itself a distinctly "good press." In the circumstances it is not surprising that books on the subject, addressed to one or other of these numerous classes of potential readers, should appear at frequent intervals.

(1) Prof. Stock's little volume is addressed to the chemist, and contains a resumé of a series of lectures delivered by him to the works chemists of a well-known German manufactory. He attempts to remove what he describes as the "thorns of theoretical physics and mathematics" which beset the tender feet of the chemist who would wander in the "Wonder-garden" of atomic structure. He has, in fact, pruned so remorselessly that the book resembles rather a sketch plan than a garden, showing little more than the direction of the main paths and the openings into some of the principal alleys. To abandon the metaphor which Prof. Stock himself suggests in his preface, the book contains a fairly complete, but very brief, summary of the various phenomena which have a bearing on the problems of atomic structure; and a still briefer exposition of some of the current theories. A very interesting volume could be written around the synopsis thus provided. The fact that positive rays and the quantum theory occupy little more than half a page each, while the theory of relativity is consigned to a footnote, indicates the extreme condensation which has necessarily been employed to compress so vast a subject into so narrow a space. The reader will, however, learn from its pages how much there is to be learnt, and a brief bibliography points out the principal sources from which the English reader can obtain further information.

(2) M. Léon Brillouin's book "La Théorie des quanta et l'atome de Bohr" is addressed to the serious student of the subject. It forms the second volume of the series of reports which the Society *Journal de Physique* is publishing on various aspects of modern physics, and maintains the high standard which was set by M. de Broglie in his initial volume, "Les Rayons X." Probably no student of physics is entirely ignorant of Planck's quantum theory, and its application to thermal radiations, or of Bohr's daring and brilliant extension of the quantum principle to the nuclear atom of Sir Ernest Rutherford which resulted in the calculation of the hydrogen spectrum, and the evaluation of Rydberg's constant; certainly one of the greatest achievements of theoretical physics in modern times.

The later developments of the theory are far less known, nor has it been, up to the present, at all an easy matter to become acquainted with them. The original memoirs of Bohr and other distinguished workers on the same problem are scattered through the pages of many periodicals in many languages. Moreover, as was inevitable in a problem so complex as that of the motion not of three only but of many attracting and repelling particles, there have been numerous false starts and incorrect conclusions, and it has not infrequently happened that, after mastering with some difficulty one of these essays, the student has found to his chagrin that it has been superseded by later work. It must be confessed, too, that the pioneers

of the theory, in their preoccupation with the extension of the subject, have not had too much pity on their weaker brethren, and it has not always been easy to discover either the exact nature or the physical basis of some of the principles to which they appeal. M. Brillouin's lucid and authoritative survey of the whole subject is, therefore, particularly welcome and valuable.

It was a happy inspiration on the part of M. Brillouin to preface his main thesis with two preliminary chapters on the quantum theory of radiation. It is a subject on which the author has himself done much valuable work, and his excellent, though brief, account provides a firm basis for the developments which follow. The succeeding chapters on the theory of Bohr, on its applications to atomic structure, and in particular the account of the principles of selection and correspondence, are equally illuminating.

It is not to be expected, from the very nature of the subject, that the volume should be easy reading. The author has not shirked the very considerable mathematical difficulties which are involved in the theory. He has, however, minimised them as far as is consistent with a proper understanding of the argument. Though it cannot be promised that the average student of physics will find his progress through the volume an easy one, he may be assured that his labours will be rewarded by a completer knowledge and a deeper appreciation of this important subject.

(3) It is in no way derogatory to M. Brillouin's excellent treatise to say that it is surpassed in interest by the report of the proceedings of the council of distinguished physicists who assembled in Brussels in 1921 under the presidency of Prof. Lorentz and under the auspices of the Solvay Institute. The number and distinction of the participants, each a master in his own particular branch, and the variety and importance of the subjects considered would in themselves suffice to raise high expectations. It may be said at once that, in the main, these expectations are fully realised by the volume which is now to hand.

Each of the twelve closely related subjects chosen for discussion was introduced at the Conference by a report on the actual position of the subject, and these reports make up the main part of the text. Thus Sir Ernest Rutherford reports on the structure of the atom, M. de Broglie on the quantum relation in the photoelectric effect, Prof. Kamerlingh Onnes contributes an account of his work on paramagnetism at low temperatures and on the super-conductivity of certain metals at low temperatures. Prof. Bohr gives an account of the application of the theory of quanta to atomic problems, which is supplemented by a report from Prof. Ehrenfest on the principle of correspondence.

It is natural that the different authors should develop their subjects in slightly different ways, and should assume slightly different degrees of previous knowledge amongst their distinguished colleagues, or perhaps we should rather say among the wider circle of readers for whom the reports were ultimately destined. In most cases, however, the reports are so well conceived and so lucidly expressed that the reader with only an elementary knowledge of the subject will have little difficulty in following a very considerable part of them. It is, in fact, an open question whether such a reader, at the expense of a little judicious "skipping" of the more recondite portions, would not attain a better appreciation of the present position of atomic physics from this volume than from many of the works ostensibly written for his special benefit. This, of course, does not apply to the one or two reports of a mathematical character, such as the profound suggestions of the president, Prof. Lorentz, in his notes on the theory of electrons which opens the volume.

In addition to their expository value, these reports have the great merit of opening up new avenues for discussion and experiment. In dwelling on the very considerable achievements which have been brought about, partly by the application of quantum theories to atomic problems, it is apt to be overlooked that these theories present formidable difficulties in addition to the fundamental one of explaining themselves. These difficulties are clearly raised in the discussions which follow the reports, and perhaps in none of them more clearly than in Prof. Barkla's discussion of M. de Broglie's report on the photoelectric effect. The discussions, which are excellently reported, are full not only of scientific but also of human interest. To the physicist, whether mathematical or experimental, in need of a subject for research they offer an ample choice of problems of fundamental importance.

It is to be regretted that so long an interval has been allowed to elapse between the meetings of the council and the publication of its report. It was not to be expected that the members of the council would allow two years to elapse before attempting the solution of some of the problems raised, and still less to be expected that their attempts should be entirely without success. In some particulars, therefore, the subject has advanced beyond the stage indicated in the reports. In the main, however, this applies only to minor problems. If it is true that intellectual satisfaction results from the discovery rather than from the knowledge of truth, a perusal of this volume will convince the reader that in this portion of physics he may confidently expect to find intellectual satisfaction for many years to come.

J. A. C.

The Ascent of Sap.

The Physiology of the Ascent of Sap. By Sir Jagadis Chunder Bose. (Cossimbazar Endowment Publication.) Pp. xv+277. (London: Longmans, Green and Co., 1923.) 16*s*. net.

THE author supplies in this book further ingenious experimental devices in which use is made of automatic recording methods and of various methods of magnifying small movements. The rate of ascent of sap is measured by a mechanical method recording the re-erection of a drooping tissue as sap enters it, and by an electrical method in which a quadrant electrometer is used to determine change of electromotive force between two points, one of which changes in turgor. By placing one electrode, carefully insulated save at the point, upon a graduated micrometer screw movement, the instrument becomes an electric probe by which the most vigorous changes in turgor are traced in the Dicotyledon stem to the living tissues in the region between inner cortex and vascular tissue.

The usual simple potometer experiment is modified into a recording potograph, whilst an ingenious bubbling method is introduced to measure the absorption of water by a cut shoot, and thus indirectly its transpiration, under varying conditions.

Many interesting observations are recorded in this account of work in the Indian climate, notably the report upon the exudation of sugar solution from cut surfaces in the stem apex or the inflorescence of the palm. This exudation is shown to be quite independent of any direct supply of sap from the absorbing system of the root.

The author's attempt to reinterpret the phenomena of the ascent of sap in the light of his new experiments is not convincing. As the result of a discussion of earlier work, mainly based apparently upon the English translations of the text-books of Haberlandt, Jost and Pfeffer, it is concluded that transpiration from the leaf and exudation from the root do not provide an adequate mechanism for the ascent of sap, whilst the rôle of osmosis is dismissed in two paragraphs. As opposed to this inadequate mechanism is advanced "a theory of cellular pulsation according to which the liquid is injected by the living cells into the wood-vascular tissue."

Later, the role of the xylem vessel seems practically to disappear—"The uni-directional propulsion of sap depends upon a sequence of pulsation from cell to cell. The sap expelled during the contraction of any one cell is absorbed by a cell higher up during its phase of expansion. There is then a propagation of a wave of contraction, preceded by one of expansion, in consequence of which the sap is, as it were, squeezed forward. A succession of such waves maintain the continuous ascent of sap." Though this may be clear to the author, the reviewer feels himself no nearer an understanding of the actual movement of sap in the plant. The demonstration of this mechanism rests upon experimental evidence that temperature, poisons, and various other external factors affect similarly sap movement and the pulsating mechanism, and upon a demonstration of electro-motive forces in tissues which are assumed to be manifestations of changes in cell turgor.

The experimental evidence is, however, not employed critically; thus it is argued that transpiration is not essential to the ascent of sap because the author's mechanical method shows a rapid rise of sap in a partially wilted chrysanthemum shoot when the cut end is placed in water, although the surface, both stem and leaf, had previously been coated with vaseline.

A Metric Campaign.

World Metric Standardisation: An Urgent Issue. A Volume of Testimony urging World-wide Adoption of the Metric Units of Weights and Measures—Meter-Liter-Gram. Compiled by Aubrey Drury. Pp. 524. (San Francisco: World Metric Standardisation Council, 1922.) 5 dollars.

FOR several years an intensive propaganda has been carried on by the "World Metric Standardisation Council" on both sides of the Atlantic in furtherance of the objects indicated in the title of this book. Apparently self-appointed, its executive includes a number of men prominent in politics, commerce, and engineering, mainly resident in the United States, but representing also Canada and Great Britain, and the council has members and correspondents in almost all countries. It is under the direction of this body that the volume before us has been compiled, bringing together a vast amount of information and data regarding the "master standards" of the world, and aiming, of course, to promote their adoption in the United States and the British Empire for all commercial transactions. It is pointed out in the introduction that far less opposition has been raised to the adoption of the litre and gram than to the metre, which is very much more closely related to industrial processes than the units of mass and volume; but on the other hand, it is not proposed to impose the use of metric measures upon production—only upon distribution.

A large proportion of the work consists of quotations from the reports of committees which have investigated the subject at various times, the writings and speeches of individuals, and Bills which have been introduced into Congress and Parliament, as well as resolutions

recorded by public bodies in favour of the metric movement; there are also lengthy lists of municipal authorities, commercial associations, and manufacturing companies which have definitely adhered to the proposed reform. The rest of the work is devoted mainly to the history of metric legislation in the United States and the British Empire, selected articles on the metric system, and a comprehensive bibliography.

From what has been said, it will be seen that the contents of the book are somewhat heterogeneous, and in parts reminiscent of a collection of press cuttings; it necessarily presents only one aspect of the question, being propagandist in the extreme. We cannot conceive of any reader faithfully perusing its pages from cover to cover, any more than he would an encyclopædia, but as a storehouse of opinion, anecdote, and similar material for the apostle of metric weights and measures to draw upon it will exercise considerable influence upon the rate of progress towards "world metric standardisation." A good index facilitates reference to the principal topics and authorities dealt with in the book, which is dedicated to James Watt as the originator of the decimal method of measurement, and contains many portraits of its advocates.

In Great Britain there is at present little evidence of a popular demand for the compulsory adoption of the metric system, though Chambers of Commerce and the Trade Union Congress annually pass resolutions advocating the reform; the Decimal Association, whilst continuing its metric propaganda, is devoting attention mainly to the decimalisation of the coinage, with the adoption of the "high-value penny" (one-tenth of a shilling, the latter retaining its present value) as the principal item in its programme. In the United States, where the benefits of decimal coinage are already enjoyed, strong efforts are being put forth to add thereto the advantages of decimalised weights and measures, and a Bill is now before Congress for that purpose. The energy devoted to the campaign in that country, of which the volume under review affords striking evidence, commands our admiration; but it must be admitted that the opposition to the movement in certain quarters is both bitter and powerful.

A. H. A.

Our Bookshelf.

Catalogue of Scientific Papers. Compiled by the Royal Society of London. Fourth Series (1884-1900). Vol. 18: Q-S. Pp. iv+1067. (Cambridge: At the University Press, 1923.) 9*l.* net.

FROM the outset this monumental work has occupied a very high position as a trustworthy work of bibliographical reference—due to the judicious extension of its range, the faultless accuracy of its entries, and the critical examination to which its author headings have been subjected. It is international in scope and appeal, but of purely British manufacture, and is now nearing the completion of the first century of its labours, for the final volume of the present series is promised next year. At first sight it might appear a tolerably simple matter to assign to their proper author headings a collection of carefully prepared transcripts of the titles of papers; but this view would not be confirmed by any cataloguer or indexer of experience. Initials of the forenames of writers have to be expanded, entries under writers of the same name and forenames to be distinguished, pseudonyms to be unmasked, and changes of name accounted for. With the spread of Western science to the East, the difficulties of accurate editing have multiplied. Nevertheless the standard of sound workmanship set by the editors of the earlier volumes has been maintained.

No great loss, we think, has resulted from the partial elimination in the present series of references to serials containing reprints, abstracts or translations of original papers. The retention of these references in the case of papers written in the less familiar languages serves most practical purposes of research. We trust that in the concluding volume Dr. Forster Morley will furnish us with complete statistics of the number of papers and their authors for the period 1800-1900, together with a chronological table or graph showing the rate of growth of scientific periodical literature for the same period.

Handbook for Electrical Engineers: a Reference Book for Practising Engineers and Students of Engineering. Compiled by a Staff of Specialists. Edited by H. Pender and W. A. Del Mar. Pp. xxiii+2263. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 30*s.* net.

THE many engineering researches both theoretical and experimental which have been carried out in recent years have created a demand for handbooks which will give the practical results obtained in a way that can be readily understood. The principal articles in this work under notice are written by well-known engineers and professors. The arrangement is excellent and there is practically no overlapping. It contains more theory than is usually found in similar works. The mathematical symbols are very clearly printed, the diagrams are excellent, and the index is very complete and well arranged. Although there are many references to radio communication, "wireless" is not mentioned. We are pleased to see that both "ground" and "earth" are given. The word "hydrology" is used to denote the "science of water." In water power engineering, for example, hydrological data such as the rainfall, natural drainage, and the velocity of the stream are required.

The Evolution of the Conscious Faculties. By Dr. J. Varendonck. Pp. 259. (London: G. Allen and Unwin, Ltd.; New York: The Macmillan Co., 1923.) 12*s.* 6*d.* net.

THIS book contains much valuable matter in the shape of introspective analysis, experimental investigation, and critical examination of theories, of the mental faculties. Dr. Varendonck leaves the impression of an enthusiastic and competent student of

conscious processes. He takes Bergson and Freud as his directors. He follows Bergson in distinguishing two kinds of memory, but he names them reduplicative (Bergson's pure memory, the integral record of the past) and synthetic (Bergson's habit-memory). He also follows Bergson in the view that memory is an essential factor of perception. His method, on the other hand, closely follows the kind of analysis with which Freud has familiarised us in the "Traumdeutung," but unlike Freud he lays no emphasis on the sex motive, nor is he in any way obsessed with the idea of symbolism. It is a sane and useful discussion of the nature and origin of intelligence.

The Principles of Geography, Physical and Human. By Dr. E. G. Skeat (Mrs. Woods). Pp. 432. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 6*s*. 6*d*. net.

DR. SKEAT has produced an attractive book, fresh in outlook, inspiring and thoroughly readable. We miss with gratitude the wearisome reiterations of the ordinary run of text-books and find the author continually turning to original sources and taking new points of view. Both matter and style commend the book and give it a place by itself. The greater part treats of the physiographical side of geography, but the concluding section gives an excellent introduction to human geography. There are many well-selected diagrams, sketch-maps, and illustrations, and a copious bibliography. The book is too advanced for most school work, but should prove valuable to teachers of geography. Its careful use could not fail to improve the teaching of the subject.

The Contact between Minds: a Metaphysical Hypothesis. By C. Delisle Burns. Pp. x+138. (London: Macmillan and Co., Ltd., 1923.) 7*s*. 6*d*. net.

MR. BURNS has produced a very clear argument. It avoids the epistemological problem of intercourse, and the psychological problem of the genesis of knowledge, and narrows itself to the discussion of the nature of our knowledge of other minds. The traditional view that the existence of other minds is an inference is rejected, and it is held that the knowledge of them is "enjoyment" in the technical philosophical meaning of the term. Mr. Burns conceives knowledge realistically as the contemplation of objects compresent with the mind which knows itself in the contemplating. Other minds are known, he thinks, not as objects contemplated, but as our own mind contemplating. It is a thoughtful essay on a problem of deep interest.

Readable School Chemistry: a Book for Beginners. By J. A. Cochrane. (Bell's Natural Science Series.) Pp. x+84+8 plates. (London: G. Bell and Sons, Ltd., 1923.) 2*s*.

MR. COCHRANE'S book deals historically, and to a certain extent popularly, with the ground usually covered in a first year's course of chemistry. It contains interesting biographical details of the great founders of the science, and deals with their important researches. These are supplemented by brief notes on modern chemistry, and the book is well illustrated with portraits. Mr. Cochrane's book should be very useful and interesting to beginners in chemistry, and its very moderate price brings it within the reach of all students. On p. 30 the name should be "Brand," and on p. 64 "Warltire."

An Introduction to Theoretical and Applied Colloid Chemistry: "The World of Neglected Dimensions." By Prof. Wo. Ostwald. Authorised Translation from the Eighth German edition by Prof. M. H. Fischer. Second and enlarged American edition. Pp. xiii+266. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 12*s*. 6*d*. net.

THE new American edition of Wo. Ostwald's book on colloid chemistry is a translation from the eighth German edition. The author's lecturing tour in America appears to have taught him how to present the difficult subject of colloids in its simplest and most dramatic form. The great success of the book is a tribute to the completeness of the education thus received.

A Text-book of Inorganic Chemistry. By G. S. Newth. New and enlarged edition. Pp. xiii+772. (London: Longmans, Green and Co., 1923.) 8*s*.

NEWTH'S text-book has been found useful for so long that it needs no description. The new edition has been revised and brought up-to-date, and will be found as clear and accurate as former editions. The sections on modern advances are very readable, and this side of the subject has not been overdone. In one or two instances the revision has perhaps not been so complete as it might have been: the long descriptions of the Leblanc process and the chamber process seem out of proportion in comparison with the very short sections on the ammonia-soda and contact processes.

Electrical Horology. By H. R. Langmand and A. Ball. (Lockwood's Technical Manuals.) Pp. xi+164. (London: Crosby Lockwood and Son, 1923.) 7*s*. 6*d*. net.

THERE are scarcely any books which give an accurate account of the progress that has been made in recent years in applying electric currents to horology. The explanations given in this work are confined mainly to the essential parts of the mechanism and the electrical and mechanical principles which they illustrate. Inventors of electric clocks who, as a rule, have only a hazy knowledge of what has been done previously, will find this book helpful.

The Phase Rule and the Study of Heterogeneous Equilibria: an Introductory Study. By Prof. A. C. D. Rivett. Pp. 204. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 10*s*. 6*d*. net.

PROF. RIVETT'S little book on the Phase Rule deals mainly with theory, the various types of equilibrium being set out under the headings of one, two, three and four-component systems. It is a useful type of book for a worker who wishes to make use of the Phase Rule in his own work, although less attractive to a general reader than a book dealing mainly with examples.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Breeding Experiments on the Inheritance of Acquired Characters.

[AT the request of the Editor of NATURE, and of Dr. Kammerer, I have translated this letter from the original German into English. Dr. Kammerer has also sent me the typewritten script of a reply to Mr. Cunningham, but in an accompanying letter he tells me that he considers it superfluous to publish this now, as he is quite satisfied with the reply which I made to Mr. Cunningham in my letter to NATURE published on June 23. E. W. MACBRIDE.]

To begin with, may I remark that I have not seen Mr. Bateson's first criticisms of my work (NATURE, July 3, 1919, p. 344) which he cites in the course of his recent letter. Whilst I was in England, my colleagues informed me of the contents of Mr. Bateson's letter of 1919, but I had unfortunately no opportunity of referring to this letter myself. I regret this all the more, since if what I had been informed of its contents was actually in the letter, it would not have been possible for me to enter into any discussion of the subject with Mr. Bateson himself. I must therefore for the present confine myself to his most recent letter (NATURE, June 2, p. 738) and the remarks which he made on the discussion which followed my lecture to the Linnean Society,[1] in which he expressly apologised to me in case I had considered his previous attacks too rude.

It is indeed remarkable that Mr. Bateson on that occasion (May 10) did not produce a single one of the many objections which are contained in his printed letter of June 2. The general impression which I gained at the meeting was that he could not think of any further objection to raise. The "vague diagrams" which he complained of appear not to be derived from my original paper (1909, *Archiv für Ent. Mech.*, vol. 28, Plate 16, Figs. 25 and 26), but—if I am not mistaken—from Plate ("Selektionsprinzip," 4th edition, p. 469, Fig. 95) in which my simple figures have been rather strongly altered and exaggerated.

Mr. Bateson must, therefore, have discovered by subsequent reflection all that during my demonstration and lecture he *did not* see. Otherwise it might have been possible for me to make him to see what he did not wish to see; I would certainly, for his benefit, have removed the Alytes specimen from the jar and he would have been able to view it—without obscuration by glass or background—from all sides under the lens: I treated it in this way during my stay in England for many colleagues (as, for example, for Mr. E. C. Boulenger and Sir Sidney Harmer).

On the occasion of the meeting of the Cambridge Natural History Society, I had at my disposal a Zeiss binocular microscope. Every unprejudiced observer could convince himself by its aid that the skin-area under discussion was of the nature of a nuptial pad—an area which according to Mr. Bateson was merely "a piece of thickened blackish-brown skin."

Numerous are the reasons which Mr. Bateson has given in order to be "absolved from basing broad conclusions on his testimony"; in a word, in order to deny the existence of the nuptial pads. First he questioned the existence of the pad; then he suggested it was merely a black patch of pigment; then, that it was present in only one specimen—consequently an accidental monstrosity; then he asserted that it was a shadow which appeared in the photograph; then, even that it had been produced by artificial retouching "in the wrong place," that is to say, on the outermost smallest finger, where in my untouched photograph (1919) some dirt had accidentally remained adhering. The microtome-sections of the pad-tissue, Mr. Bateson suggested, had been taken from another type of Anuran; then, since it appeared that homologous tissues of other species of Anura were of a different character, that these sections did not show genuine pad-tissue.

The most recent communication in which Mr. Bateson gives the impression which he received from the specimen which I demonstrated at the Linnean Society is capable of only two explanations, namely, either that Mr. Bateson is not an acute observer or that his theoretical views have affected his vision. In neither case can he escape the criticism that in describing "Dr. Kammerer's Alytes" he proceeded with a rashness unusual in a scientific man, especially when he makes slightly veiled accusations of "correcting Nature" against conscientious observers. We may now enumerate the points on which Mr. Bateson's "doubtful memory" has led him astray, namely:

(1) It is incorrect to say that my preparation of Alytes prevented a view of the dorsal aspect of the hand and only showed the palmar aspect—to make such a preparation it would have been necessary to fasten each finger flat against the substratum.

(2) It is incorrect to say that the black colour is restricted to the palmar aspect. (Why should Mr. Bateson assert this when he had not seen the dorsal aspect?) Actually the pads extend to the dorsal aspect and are therefore not "in the wrong place." It is curious to find Mr. Bateson prescribing to Nature the "right" place—Nature which has produced much more "astounding" and "curious creatures" (cf. Trichobatrachus) than my modest cultures of Alytes.

(3) It is incorrect to say "The right hand showed nothing special." On the inner side of the wrist-joint, on the insertion of the ball of the "thumb," there has been regenerated[2] a distinct dark pad—of course, not so large as that on the left hand.

(4) It is incorrect to say that the pad presents only "a dark uniform surface but no papillary or thorny structures." I send herewith an enlarged photograph in which "rugosities" can be seen on the edge of the pad with the naked eye. [I have verified this, but doubt very much whether the rugosities would appear in a print reproduced in NATURE.—E. W. M.] Unfortunately this photograph is taken from the palmar aspect; it was not foreseen that Mr. Bateson would criticise this, the most advantageous, position, in order to deny the presence of the pad on the dorsal surface, and to call in question the pad-nature of the whole structure. It is probable that the majority of my English colleagues have no idea how difficult it is to obtain a satisfactory photograph in our impoverished Austria. Of course, at the very first opportunity I shall have the upper side photographed; perhaps Mr. Bateson in his desire for truth will provide the necessary camera and photographic materials.

Dozens of scientific men have seen the pads and are now convinced; only Mr. Bateson has seen nothing. Unfamiliar as he is with this special department, he expects to see the same as can be seen in

[1] NATURE, May 12, 1923, p. 639, column 2, line 10, should read "macroscopic observation," not "microscopic."

[2] Dr. Kammerer stated at the meeting of the Linnean Society that the original pad on the right hand had been removed for the purpose of making microtome sections.—E. W. M.

Rana agilis. His assertion that the pads of *Alytes obstetricans* are not pads because they have a different appearance from those of *Rana agilis* is as unreasonable as it would be to maintain that *Alytes obstetricans* is not a Batrachian because it does not look like *Rana agilis.*

Lastly, a few words on the question of adaptation. In my lecture I avoided speaking of adaptation because this term involves a hypothetical and teleological element: I feared that to use it might lead to endless unfruitful discussion. Unfortunately, I was unable to prevent this; Mr. Cunningham discussed his own theory of adaptation in a way that had little to do with the facts which I had cited. I definitely declined to enter into this subject in my reply, simply because it is not usual for the discussion to wander so far from the subject of the lecture. So far as the nuptial pads are concerned, may I refresh Mr. Bateson's memory so far as to remind him that not only my Alytes but also other Batrachians, and especially the Discoglossidæ (to which Alytes belongs), have pads on places which never come into contact with the female? *Bombinator pachypus*, for example, develops pads on two or three toes of the *hind* foot (cf. Schreiber, "Herpetologia Europæa," 1912, p. 175). Are these "in the wrong place" or "retouched" by Nature?

I willingly admit that the traditional explanation of the pads, namely, that they are produced by friction with the skin of the female, may possibly be a fable: for that reason I have referred to this view with reserve and scepticism in my paper (1919, pp. 331, 339, 353). It is true that the spread of the thickening to regions of the skin which in the copulatory act do not undergo friction, is no valid ground for rejecting the theory. Mr. Bateson has doubtless himself observed that pressure thickenings and blisters often extend beyond the original zone of irritation. But it is by no means impossible, although of course not proved (Kammerer, 1919, p. 340), that life in water produces the pads; if this were so we should have a case of direct passive production but not of active adaptation. The correctness of my observations and their relevance to the theory of heredity, is not affected whichever of the explanations is adopted.

PAUL KAMMERER.

DR. BATESON, in a letter to NATURE of June 2, raises the very interesting point as to whether the appearances alleged to be "nuptial pads" in *Alytes obstetricans* are really such. Whatever their nature, they are undoubtedly organised structures; and if they should prove not to be "nuptial pads," they will have to be regarded as a new and arbitrary feature which has appeared after subjection to an experimentally altered environment for two or three generations, and which persists for at least a few generations after a return to normal conditions. In other words, it would seem that Dr. Kammerer has had success in an experiment which is almost analogous to those ancient researches in which was attempted the reproduction by hereditary means of a surgically impressed modification.

However, Dr. Kammerer has clearly stated that in his opinion the only feature of the experiment which in any way justifies such a view is that the excrescences in question are not dependent for their development on the presence of a testis, and in this differ from the nuptial pads of the better known Amphibia Anura.

Dr. Bateson points to two details which make "the appearance quite unlike that of any natural *Brunftschwielen*": first, that in Alytes there is a "dark uniform surface . . . without the dotting or stippling so obvious in true *Brunftschwielen*"; secondly, that their position does not correspond to that of the nuptial pads in *Rana agilis*.

Lataste's excellent drawings (*Ann. Sci. Nat.* (6), tom. 3, pl. 11, 1876) show that a uniform blackness of the outer layer of the pad is a characteristic feature of the Discoglossidæ (to which Alytes belongs) and distinguishes them from other Anura. The fully developed pads of *Bufo vulgaris* are also uniformly black, and I have recently found that when such full hypertrophy of the outer epithelium is inhibited, as occasionally happens from obscure causes, it may be induced by making the male maintain a sexual embrace for a week or two. The same effect may be produced in the summer condition of the pad, and I have found that the hypertrophy takes place even when the male maintains his tonic embrace on thin air.[1]

The pad of the Alytes "water-breed" also resembles that of the Discoglossid Bombinator in having a complete layer of black pigment in the cutis vera which would further contribute to the uniform dark appearance which Alytes so well and characteristically shows. Photographs show another interesting point. Very distinct connective-tissue papillæ are developed from the cutis vera in association with the epidermal spines. Such papillæ are but very slightly developed in the Discoglossidæ, though Lataste's picture of Discoglossus shows traces, whilst they are a characteristic feature of the pads of many other Batrachians.

The epidermal spines are very obvious in the intact specimen, as I have repeatedly seen both with lens and binocular microscope, and as many others have witnessed in my presence. Of course, they are practically impossible to photograph on account of the glistening of a wet specimen, but a photograph at least makes clear what areas of skin are affected. These include nearly the whole of the palm, the radial surface of the inner metacarpal and part of the first phalangeal joint of the thumb, and more or less of the ventral and radial surfaces of the forearm, passing over the dorso-radial margin of the inner carpal tubercle. The Discoglossidæ are remarkable for the very various positions in which the histological features of *Brunftschwielen* may manifest themselves, on the chin, belly, thighs, toes of the feet even; in other words, they are not necessarily dependent on contact with the female for their development. Dr. H. Gadow has shown me his sketch of the nuptial pad in *Alytes cisternasii*, Bosca., where it is developed on the tip of the thumb, extending on the palmar surface. Even in the common toad I have frequently observed the nuptial rugosity extending on to the palmar surface of the inner carpal tubercle.

Questionable as it is to draw conclusions on anatomical points by analogy from other animals, it is even more unsafe to do so as regards their habits and postures; Alytes does not belong even to the same suborder as *Rana agilis*. De l'Isle (*Ann. Sci. Nat.* (6), tom. 3, p. 18), in his account of the cervical clasp of Alytes, says with regard to "les paumes," "les applique contre le cou de la femelle." Moreover, although he gives no definite description of the attitude of the hands during the inguinal clasp, he describes how, with the fingers interlaced, the two backwardly directed internal digits participate in the well-known chafing of the cloaca, which seems to me anatomically impossible if the hands are so much everted that the palms do not come in contact with the pubic region, the groins, or at least the thighs of the female.

MICHAEL PERKINS.

Trinity College, Cambridge,
June 16.

[1] The surgical details of this experiment are of no importance in the present connexion.

Light-Quanta and Interference.

In a very important and stimulating paper on the scattering of X-rays by light elements (*Phys. Review*, May 1923), Prof. A. H. Compton suggests that a study of the problem of scattering by atoms with tightly bound electrons and by groups of atoms may shed some light upon the difficult question of the relation between interference and the quantum theory.

In an investigation of this kind it may be useful to keep in mind an important difference between an electron and a light-quantum, which depends on the fact that generally most of the electron's energy is unavailable, while the whole energy $h\nu$ of a light-quantum seems to be available. This indicates, of course, that a light-quantum is a simpler form of matter than an electron or proton.

Roughly speaking, a light-quantum possesses a large amount of available energy and a small momentum, while a moving electron generally possesses a small amount of available energy and a comparatively large momentum. As a rule, then, we cannot expect a free or lightly bound electron to absorb the whole energy of a light-quantum. It is indeed possible, according to the theory of Compton and Debye, for an electron which encounters a light-quantum $h\nu$ to move away with a kinetic energy equal to $h\nu$ if the electron has an initial kinetic energy nearly equal to $h\nu$, but this case is not of much physical interest. When, however, an electron is tightly bound to an atom, so that some of the energy of an impinging quantum may be transformed into potential energy, there is a possibility that the whole energy of the quantum may be absorbed in a single impact.

If we admit that the energy of a quantum can be absorbed bit by bit, it does not follow that the type of absorption considered by Compton is the only one which can occur. Let us suppose that a quantum $h\nu$ after encountering an atom is transformed into a quantum $h(\nu - d\nu)$ travelling in the same direction as the original quantum. Assuming that the atom (of mass m) acquires the energy $hd\nu$ and momentum $hd\nu/c$ lost by the quantum, the centre of mass of the atom may be supposed to move forward with velocity $hd\nu/mc$ and a kinetic energy $h^2(d\nu)^2/2mc^2$, which is generally negligibly small in comparison with $hd\nu$. The acquired energy $hd\nu$ may therefore be energy of small oscillations about a state of steady motion. To ascertain the nature of these oscillations we represent the incident quantum by a field of type

$$E_x = H_x = 0, \qquad E_y = H_z = \frac{\partial\Omega}{\partial y} f\left(t - \frac{x}{c}\right),$$

$$E_z = -H_y = \frac{\partial\Omega}{\partial z} f\left(t - \frac{x}{c}\right),$$

where $$f(t) = \int_0^{2\pi\nu} \cos(pt + \alpha)dp.$$

(See Nature, April 28, p. 567.)

The emergent quantum may be represented by a field of the same type with $\nu - d\nu$ instead of ν, while the field which is really effective in producing the oscillations is the difference of these two, and is of the same type with

$$f(t) = \int_{2\pi(\nu - d\nu)}^{2\pi\nu} \cos(pt + \alpha)dp.$$

When $d\nu$ is very small, this represents approximately a homogeneous train of waves of frequency ν. The small oscillations set up in the atom are thus specified approximately by a trigonometrical function of type $2\pi d\nu \cos(2\pi\nu t + \alpha)$ and are practically undamped and of frequency ν. The phenomenon of interference may, then, be quite compatible with quantum theory, for it may depend really on an interference of small oscillations produced in the atoms by the quanta. If a number of quanta in phase strike the same atom, the small oscillation may become large and eventually result in a quantum jump, but the growth of an oscillation may depend, of course, on the phenomenon of resonance.

Since we have endowed a quantum with a field, a single quantum may produce small oscillations in a large number of atoms in accordance with Compton's idea, and so a second difficulty in the theory of interference may not be so great as it seems at first sight.

H. Bateman.

Institute of Technology,
Pasadena, California.

A Mountain Mirage.

As part of a magnificent view from Ben More of Mull on July 13, my sister and I saw a striking mirage on the Coolins of Skye. To begin with, Skye and all the Highlands to the eastward of it were covered by a level sheet of white cloud, with the highest peaks just showing clear and sharp above it. Then, starting from the sea, this cloud gradually melted away, and revealed a magnificent prospect extending far past the Coolins into the mountains of Ross. But as the cloud first melted it left the Coolins strangely transformed, each of their jagged crests drawn up into a fantastic spire. In the course of a very few minutes this effect died away and the Coolins took on their natural outline.

This was about 6.30 p.m., summer time. Presumably the mirage had some connexion with the cloud sheet; at one stage of its absorption the sheet must have been represented by a refracting layer, which would be very nearly at our eye-level. The air was remarkably clear, not only to the north but also to seaward. For some time a long line of the Outer Hebrides, from about South Uist to Barra Head, was visible, pale but perfectly clear-cut.

E. Leonard Gill.

Royal Scottish Museum, Edinburgh,
July 18.

Probable Aeolian Origin of Greywether Sandstone.

On reading Mr. C. Carus-Wilson's note (Nature, March 3, p. 292) referring to the long tubular holes seen in sarsen stones, which he says suggest "the work of marine annelids, anterior to the consolidation of the rock," it struck me that some important light may be thrown on this subject by observations made on this side of the globe. First of all one might suggest that if these were annelid burrows they would have an average diameter, and there seems to be no evidence that the greywether sandstone, with its once softer siliceous matrix, was of marine origin. In Australia we have a great extent of country along the coast and inland, covered with dune formation, and these deposits enclose enormous quantities of vegetation. Plants that are growing on or near these dune areas, sometimes under swampy conditions, are covered over with sand, which is being blown about the stems of such grasses, reeds, and shrubs so as to completely enclose them. When the dune rock, some of which dates back to the early Pleistocene, has consolidated, a fracture reveals tubular holes which might suggest worms, but from their positions, at all angles, as well as vertical, and from their varied diameter and outline, are easily traced back to plant origin.

From many years' observations upon our Australian dunes, I cannot help thinking that here we have a similar process going on, which obtained during the arid interludes of the Eocene in the south of England.

Evidence of cross-bedding, which is inseparable from this type of rock, would be easily lost, since the greywethers are secondarily silicified or "concretionary." From conversation with the late Prof. Rupert Jones, than whom I knew no keener observer, I gathered that he firmly believed in the rootlet and stem structure of these perforations (see *Geol. Mag.*, 1901, pp. 54-59 and 115-125). Another recorded instance of enclosed rootlets is given by Wm. Carruthers (*Geol. Mag.*, 1885, p. 361), who found in a weathered sarsen stone from Abury a root with rootlets, which he doubtfully ascribes to a palm, and in the position of growth.

It would be interesting to discover any positive evidence of cross-bedding in these white Tertiary sandstones. The Bagshot sands, by the way, both in Surrey and Kent, are often strikingly and steeply cross-bedded, and this, from a study of our dune rock in Victoria, points to aeolian formation rather than to marine current action. FREDK. CHAPMAN.

National Museum, Melbourne,
June 15.

Barometric Pressure in High Latitudes.

I AM much obliged to Mr. L. C. W. Bonacina (NATURE, July 21, p. 100) for pointing out a clerical error in my statement concerning the winter and summer Arctic pressures. The correction gives greater emphasis to my contentions.

My point is that in the Arctic regions, even during the winter when the sun's light does not reach the area to any extent, the pressure is low, indicating a sufficiently warm stratosphere able more than to counterbalance the effect of the cold lower troposphere.

The lower troposphere over the polar areas is undoubtedly very cold, and this cold air often flows outwards from the poles for some distance. I am not aware that my views on this point are in conflict in any way with those of Dr. G. C. Simpson, Prof. Mohn, or Prof. Bjerknes, except on very minor points. What I have attempted to explain is not why these northerly Arctic winds exist, but rather why they do not blow from the poles to the equator. The real difficulty, to my mind, is to account for the westerly poleward winds of middle latitudes.

Mr. Bonacina says "there must, on the average, be a relatively high surface pressure about the poles." But all the charts show a relatively low pressure. However, an outflow of cold air from the poles will occur if the density of the *lower* troposphere decreases with sufficient rapidity as we move towards lower latitudes; and this is what actually often occurs, for the temperature rises as we move from the poles.

R. M. DEELEY.

Tintagil, Kew Gardens Road,
Kew, Surrey,
July 20.

Phototropic Compounds of Mercury.

IN NATURE of June 9, p. 775, Messrs. Venkataramaiah and Rao describe "A New Phototropic Compound of Mercury" of the composition $Hg\begin{matrix}\diagup HS\\ \diagdown CNS\end{matrix}$, which they regard as "the most phototropic compound as yet known"; or that this compound shows appreciable change in colour on exposure to light in less time than that required by any other known phototropic compound. In 1917, while working in the College of Science, Calcutta, in an attempt to prepare $(SHgI)_2$, described by Ray (Trans. Chem. Soc., 111, 109), without using any organic compound, I obtained $2HgS.HgI_2$, which showed phototropy to a remarkable degree. The orange yellow powder turned black very quickly on exposure to sunlight, but only gradually in diffused daylight. On keeping the black powder in the dark, the reverse change took place. At room temperature, it took several hours to recover, but at higher temperatures the change of colour was quicker; at about 85° C., for example, only a few seconds. Both varieties had the same chemical composition. This substance was exhibited before the Indian Science Convention of that year, and a preliminary note was published in the Report of the Indian Association for the Cultivation of Science, 1917. Since then I have found that phototropy is exhibited more or less by all the complex sulphides of mercury of the general formula $HgS.HgX_2$ or $2HgS.HgX_2$, where X is a halogen or a monovalent acid radicle, including CNS, of which $2HgS.HgI_2$ is the most sensitive.

The sensitiveness to light depends to some extent, as might be expected, on the nature and area of the surface exposed. I have found that paper coated with an emulsion of $2HgS.HgI_2$ in gelatin is much more sensitive to light than the powder. In fact, it turns black more quickly on exposure to light than the ordinary gelatino-chloride paper used in photography. But it is very curious that in this case the reverse change of colour does not take place on keeping in the dark or heating. Evidently the gelatin somehow prevents the reversal. A detailed report on these inorganic phototropic compounds will be published in due course. M. L. DEY.

Central Chemical Laboratory,
Kirkee, India, July 5.

Melanism in the Lepidoptera and its Possible Induction.

BELIEVING that light can be thrown on some of the problems of evolution by an experimental investigation of the development of melanism in lepidoptera, we have been studying the influence of the food plants growing in critical areas, and also of inorganic substances likely to occur in or on the plants of such regions, on races of moths imported from non-melanic districts. Our cultures have been reared at two centres; some at Birtley (Durham), an area producing a very large number of melanic species, and others at Hexham (Northumberland), where melanism is much less prevalent, although not absent. The work is not finished, but certain facts seem worth publishing at once, particularly in view of the recent controversy as to the value of Kammerer's experiments.

We began with Kentish races of *Tephrosia crepuscularia* Hb., and Kent and Hampshire strains of *T. bistortata* Goeze, rearing them on hawthorn gathered by the roadside at Birtley, and in the third generation of *T. crepuscularia*, a species in which we have proved melanism to be a Mendelian dominant, obtained one black female in a brood of 23 insects. *T. bistortata*, on the other hand, showed no change in the fourth generation, at which stage the eggs from one pairing were sent to Hexham and others reared at Birtley, where in the next (fifth) generation one black female was obtained from about 90 pupæ. The eggs at Hexham, cousins to those at Birtley, were divided into four batches, the larvæ in one case being fed on local hawthorn and in the others on hawthorn impregnated with a metallic salt. In each culture one or two black moths appeared, the broods averaging two dozen in number.

In 1918 pupæ of *Selenia bilunaria* Esp. were obtained from Kent, and broods resulting from these reared at Birtley on hawthorn from the roadside. In the following year the spring brood, the second lot fed at Birtley, gave a batch of moths containing a large number of typical insects, several melanochroic forms together with two insects uniformly leaden black. A black female was paired with an unrelated typical male, and F_1 and F_2 generations secured; the results suggested that the melanism was recessive, as in the allied moth *Ennomos quercinaria* Hufn. Another batch of ova was obtained from a typical wild Abbot's Wood (Sussex) female in July 1921, and after two generations had been reared at Birtley, eggs were sent to Hexham. Some of the larvæ were fed on prepared hawthorn, the salts used being lead nitrate and manganese sulphate. The moths emerging in the spring of 1923 showed no particular variation, but were paired, and the treatment continued. The summer brood proved extremely interesting. The controls began to show the effects of inbreeding, only 12 moths resulting from 60 eggs, and 3 of these were dwarfs; but there was no melanism. From one batch of larvæ fed on hawthorn containing lead nitrate 12 males and 15 females were bred; all were of normal size, but 1 male was practically black. Another such batch gave 20 males and 11 females, 1 male again being melanic. A fourth section, reared on hawthorn charged with a manganese salt, yielded 11 males and 9 females; these displayed both melanism and melanochroism, 6 males and 2 females being of the black type, whilst insects absolutely typical were practically absent. All of these melanic forms are fairly uniform in colour, showing no markings except an almost white line such as is so common a feature of melanic lepidoptera.

In partnership with Mrs. Garrett, one of us recently directed attention in these columns to the effect of lead on *Smerinthus ocellatus*, and the same workers have now tried it with *Amorpha populi*, the eggs originating with a wild Hexham female. The larvæ again fed up more rapidly, but whereas the *S. ocellatus* pupæ were heavier, those of *A. populi* were about 15 per cent. lighter than those of the controls. They were perfectly healthy, however, and moths were obtained from every pupa save one. Though there was no definite melanism, there was a tendency towards it, the colours being more intense and the markings more clearly defined; the difference was sufficiently great to enable one of us, who had not seen the moths before, to sort them correctly without any clue as to their history.

As the investigation is being continued, and the study of the inheritance of the induced melanism well in hand, we content ourselves with a mere statement of the facts; next summer we hope to be able to publish fuller details.

F. C. Garrett.
J. W. Heslop Harrison.
Armstrong College, Newcastle-upon-Tyne,
July 27.

The Reported Meteorite at Quetta.

The issue of Nature of May 26, p. 704, contains a short communication from my Department correcting a report concerning the fall of a meteorite at Quetta. Further inquiries make it desirable that the opinion in that letter should be modified. Though no traces of a meteorite can be identified in the material collected, it does not necessarily follow that a meteorite did not fall.

During a storm at Quetta on the afternoon of January 25 last, a large ball of fire is reported to have fallen and struck a stack of baled *bhoosa* (chopped straw) in the Military Grass Farm Stack-yard. The stack, composed of 12,800 bales, was for the most part consumed by fire, and amongst the ashes were found some three tons of a hard dark stone. Portions of this stone were forwarded to the laboratory of the Geological Survey and found to consist of slag, parts of which showed a ropy structure and slightly scoriaceous texture. As we were informed that no one had actually seen the fireball strike the stack, it was at first thought that the latter was ignited by a simple flash of lightning. Later information, however, makes it possible that a meteorite did actually fall into the *bhoosa* stack. Not only was the "ball of fire" witnessed by several people, but the men who were set to work on top of the stack extinguishing the fire immediately after its outbreak reported a hole in the stack 18 inches wide, and their observation was confirmed by Conductor Trewhella, who noticed that the hole led towards the centre of the stack.

The possible sequence of events may be reconstructed as follows: The *bhoosa* was struck and ignited either by a meteorite which burned its way to the base of the stack, or by a simple flash of lightning. The intense heat fused the iron bands binding the bales of *bhoosa*, and this iron combined with the silica in the *bhoosa* itself or with any mud roofing which may have been present. Mr. A. J. Gibson, of the Punjab Forest Service, has reminded me that the tissues of the Gramineæ contain an unusually large percentage of silica, and 12,000 bales would probably supply sufficient to form most of the three tons of slag, consisting of silicate of iron, free iron, and impurities.

The meteorite, if there were one, was itself probably of iron, and would have mixed with and become part of the fused slag. Unmelted fragments of the iron bands of the *bhoosa* bales were found in the cooler portions of the melt. In such circumstances it is of course impossible to identify any remains of a meteorite in the slag.

E. H. Pascoe (Director).
Geological Survey of India,
Simla, July 9.

Scientific Names of Greek Derivation.

In Nature for July 7, p. 10, Prof. Cole criticises "American authors" for using the term dinosaur, instead of clinging as he does to "deinosaur." In a previous number of Nature (July 1, 1922, p. 21) the reviewer of an article on the Deinodontidæ takes the authors to task for not using "what is now considered the more correct rendering of the Greek, as Dinodontidæ." What can a poor American author do to be saved?

In fact, the usual custom among American and Canadian palæontologists has been to follow the rules of the International Code for names of genera and families, and otherwise adhere to the original spelling of scientific names, although some of us have had sufficient classical training to dislike having to use badly composed or wrongly transliterated names. Dinosauria was Owen's spelling of the word and Deinodontidæ is formed according to the rule from the radical of Leidy's genus as originally proposed.

While the rules and recommendations of the Code are a sufficient guide for future coining of names, its retroactive applications are not altogether clear, and it does not provide any definite guide for the spelling of the larger group names or other scientific terminology. Is there any scientific dictionary to which one could refer as internationally authoritative? Or could the matter be taken up by the next international congresses of zoology and geology?

W. D. Matthew.
American Museum of Natural History,
New York, July 17.

Hardness Tests.

EVERY one has a general idea of what is meant by hardness—that the diamond is harder than steel, and steel harder than copper. The workman judges of hardness as the resistance of a material to the action of his cutting-tools or files. But there is as yet no rational definition of hardness. A property connected with hardness is resistance to abrasion or wear. As Sir Robert Hadfield has said, rails are demanded which will not wear out quickly and tyres which will not need renewing every few months. It was entirely for these reasons that modern qualities of steel were produced. To some extent hardness is opposed to ductility or toughness. Very hard materials are generally brittle. The engineer requires a material in which hardness is obtained without too great a sacrifice of toughness.

The earliest scale of hardness is that proposed by Moh. He selected ten minerals arranged in order such that each would scratch the one next below it in order and be scratched by the one above it in order. On this scale talc has a hardness 1 and diamond a hardness 10; iron has a hardness of 4·5. But the scale is qualitative only and arbitrary. Prof. Turner has used a balanced lever turning on a knife-edge. The free end carries a diamond. The surface to be tested is polished. The hardness is taken to be the weight in grams on the diamond necessary to produce a definite scratch. The method is useful, but there are practical difficulties in applying it. Recently Mr. Hankins, at the National Physical Laboratory, has modified this test. He uses a diamond shaped so as to produce an indentation furrow rather than a scratch.

The diamond is loaded with weights and drawn over the surface to be tested. The widths of the scratches with different weights is measured, and it is found that the square of the widths plotted against the weights fall on a straight line passing nearly through the origin. Hence Mr. Hankins takes as the hardness number the quantity

$$k=\frac{P-p}{w^2-q},$$

where P is the load on the diamond, w the width of scratch, and p and q small constants not depending on the material tested.

Various investigators have used an indentation method for determining hardness. Such a test is very suitable for ductile metals, but how far it is applicable to brittle materials is uncertain, though this is not of practical importance. The indenting tool has been a knife-edge, ball, cone, or pyramid.

In 1895 and 1900 Lieutenant-Colonel Martel communicated two very interesting papers to the Paris Congress on Testing Materials. He used chiefly a falling monkey with various forms of indenting points and various heights of fall. He concluded that (1) for a given material the work of indentation is proportional to the volume of the indentation and independent (within limits) of the form of indenting tool; (2) that the pressure causing indentation is at each instant proportional to the area of the indentation normal to the pressure. If V is the volume of the indentation, P the weight of the monkey, and h the height of fall, then Martel's hardness number is

$$D=\frac{Ph}{V}$$

in kilogram-millimetre units.

About 1900 Brinell introduced the indentation test, which has been most widely used. A very hard steel ball 10 mm. in diameter indents the material by a gradually applied load of 3000 kilograms, which rests on the ball for some seconds until the indentation is complete. The radius of the indentation is measured by a microscope. If P is the load, a is the radius of the indentation, and r the radius of the ball, then Brinell's hardness number is

$$H=\frac{P}{2\pi r(r-\sqrt{r^2-a^2})}.$$

The quantity in the denominator is the spherical surface of the indentation; and the units are kilograms and millimetres. In practice it is necessary to use a smaller load for soft materials and sometimes to use a smaller ball. Then the hardness number obtained is not the same unless the load P_1 and the ball radius r_1 satisfy the condition

$$\frac{P}{r^2}=\frac{P_1}{r_1{}^2}.$$

This is Meyer's law confirmed by Mr. Batson, of the National Physical Laboratory. If the law is complied with the indentations are geometrically similar.

Prof. Ludwik uses a right-angled cone instead of a ball, so that the radius and depth of the indentation are equal and the indentations for different loads are similar. He also takes the hardness number to be the load divided by the conical area of the indentation.

Prof. Föppl placed two cylinders of the material to be tested at right angles and pressed them together in a testing machine. The pressure per unit of flattened surface is taken as the hardness number. Prof. Henderson, of Greenwich, has introduced a similar test, the material being in the form of square prisms.

For ordinary materials of construction, Brinell's test has proved most useful. It rather fails for very hard materials from the smallness of the indentation and the distortion of the ball, and efforts have been made to find another test or to revive the scratch test for such cases.

A new instrument which appears to be very sensitive has been introduced recently by Messrs. E. G. Herbert, Ltd., of Manchester (see NATURE, April 28, p. 583). This consists of an arched pendulum weighing 2 or 4 kilograms. At its centre is a ball 1 mm. diameter of ruby or steel. By adjusting screws the centre of gravity of the instrument can be made to coincide with the centre of the ball. A weight over the ball can be adjusted to lower the centre of gravity of the instrument to 0·1 mm. below the centre of the ball when the time of swing on a very hard surface is 10 sec. A level tube over the ball is graduated from zero at one end to 100 at the other. Two scales of hardness are

proposed: (1) Inclined to zero and left, the reading of the level bubble at the end of the first swing is taken as the hardness number. The softer the material, when the indentation due to the weight of the instrument is deep, the shorter is the swing. (2) The time period of an oscillation is another measure of hardness. The time in making ten swings is taken as the hardness number. Thus the time of ten swings on glass is 100 sec., on hardened steel 50 to 85 sec., on soft steel 20 to 40 sec., on lead 3 sec. The pendulum is set in oscillation through a small arc by the touch of a feather. The sensitiveness of the instrument is very great, and it gives definite indications with the hardest materials.

Dr. Stanton has designed an ingenious instrument in which the deformation of a very hard ball used in the indentation test is substituted for the deformation of the material. This gives a much opener scale for hard materials. But the instrument is one for laboratory rather than workshop use.

W. C. U.

Structural Colours in Feathers.[1]

By Prof. WILDER D. BANCROFT.

IN pigment colour we have absorption of light due to the molecular structure of the substance under observation. We speak of structural colours when the observed colour is due to, or is modified strongly by, the physical structure. Typical cases of structural colour are observed with prisms, diffraction gratings, thin films, and turbid media. In the case of feathers we find that the blacks, reds, oranges, yellows, and browns are pigment colours, but that the ordinary blues and greens are not blue and green by transmitted light, and that the so-called metallic or iridescent colours, such as those of the peacock, are structural colours.

Biologists have often talked of prismatic or diffraction colours, apparently because those were the only structural colours that they knew about; but they have never tried to show that any arrangement of prisms or gratings would give the actual colours observed. Since prisms and gratings give no colour in a uniform diffused light, it is only necessary to look at a feather on the north side of a house, preferably on a grey day, and all prismatic or grating colours will disappear. Nothing of the sort happens, except to an almost negligible extent, with some moths.

If we have a turbid medium with fine particles, the scattered light is predominantly blue—Tyndall blue—and the transmitted light is reddish. Familiar examples of this are skimmed milk and cigarette smoke. The blue of the sky is also a Tyndall blue, the scattering being due in large part, however, to the molecules of nitrogen and oxygen, as was shown by the late Lord Rayleigh. In feathers of the non-iridescent type, Haecker showed that we have myriads of tiny bubbles in the horn which scatter the light, and a black backing which cuts off all transmitted light. On filling the bubbles with a liquid having approximately the same index of refraction as the horn, the scattering ceases and the blue colour with it. On putting in carbon bisulphide, which has a much higher index of refraction than the horn, the blue reappears because we again have a turbid medium. The blue of the feathers can be reproduced wonderfully by heating a hard glass tube until it begins to devitrify. The myriads of small crystals which are formed scatter the light, and a beautiful blue is obtained if the inside of the tube is coated with a black varnish to eliminate transmitted light.

In almost all cases of non-iridescent green feathers, there is no green pigment and the effect is due to the superposing of a yellow pigment on a structural blue. This can be shown in a number of ways. If we take a green feather and boil it long enough in alcohol, the yellow pigment dissolves and the feather turns blue. If we expose the green feather long enough to an intense light, the yellow pigment bleaches and the feather becomes blue. If we scrape the surface of the feather with a sharp knife, we can peel off a layer of yellow horn and the feather again turns blue.

The metallic or iridescent colours, such as those of the peacock, were considered by Rayleigh to be the interference colours of thin films like those observed with oil films on the streets, while Michelson believed that they were so-called surface colours from solid pigments. Fuchsine gives a yellow-green surface colour quite different from the magenta colour by transmitted light. Our experiments have satisfied us that Rayleigh was right and Michelson wrong. There are no bright-coloured pigments in peacocks' feathers or in any feathers of that type. In the case of the peacocks there are triple films, but this is not so in the neck feathers of the pigeon.

Nobody has ever extracted any bright-coloured pigment from any iridescent feather, and we have confirmed this, using a large number of organic solvents. The change of colour with the angle of incidence is what it should be for thin films, while magenta shows practically no change of colour with changing angle of incidence if one does not use polarised light. If one swells the feather by exposing it to phenol vapour, the change of colour is what one would predict from a thickening of the film. If one destroys the dark pigment, the colour disappears almost completely, though it can still be seen at certain angles. It can be brought back by staining the feather with a dark pigment. In the white pigeon, the iridescence of the neck feathers is very difficult to see, but it can be brought out vividly by staining the feather. Unfortunately the physical structure of the tail feathers of the white peacock is quite different from that of the ordinary peacock, and consequently staining does not develop brilliant colours.

The average thickness of the films in the iridescent feathers is about 0·5 μ or 1/50,000 inch.

[1] Synopsis of a lecture delivered at University College, London, on June 1, at the University of Aberdeen on June 7, and before the Manchester Literary and Philosophical Society on July 19.

Obituary.

Prof. C. Niven, F.R.S.

PROF. CHARLES NIVEN was born in September 1845, and was one of four brothers who achieved the distinction of being wranglers. He entered the University of Aberdeen as a student in 1859, graduated there with first class honours in mathematics and natural philosophy. In 1863 he proceeded to Trinity College, Cambridge, and in 1867 was senior wrangler. In the same year he was elected a fellow of Trinity College and was appointed professor of mathematics at Cork.

It was during the tenure of the professorship at Cork that the greater part of Prof. Niven's contributions to mathematical and physical science was published. Between 1868 and 1880 he produced thirteen papers on various subjects. His first paper, on the application of Lagrange's equations to the solution of questions of impact, was published in the *Messenger of Mathematics* in 1868, and, although the method is implicitly involved in Lagrange's general dynamical scheme, its effectiveness in dealing with problems of impulsive motions had previously not been adequately appreciated. This paper was followed by three papers on the wave surface, a paper on rotatory polarisation in isotropic media published in the *Quarterly Journal of Mathematics*, papers on the mathematical theory of elasticity in the Transactions of the Royal Society of Edinburgh, the *Quarterly Journal of Mathematics*, and the *Philosophical Magazine*, and a paper on a method of finding the parallax of double stars, and on the displacement of the lines in the spectrum of a planet, published in the Monthly Notices of the Royal Astronomical Society. In 1879 he communicated a paper on the conduction of heat in ellipsoids of revolution to the Royal Society, and in 1880 a paper on the induction of electric currents in infinite plates and spherical shells; both papers were published in the Philosophical Transactions. These two papers are the most outstanding of Prof. Niven's writings; the analytical skill exhibited in them is very great, and the results obtained are of importance.

In 1880 Prof. Niven was appointed to the chair of natural philosophy in the University of Aberdeen. The demands made on his time by the duties of his professorship and the development of the department appear to have prevented him from pursuing his researches farther. In 1917, however, he sent to the Admiralty a paper on the theory of the location of sound in water, which was of service in connexion with the campaign against submarines, but the paper was never published. His tenure of the chair at Aberdeen extended from 1880 to 1922, and during that time the department of natural philosophy increased greatly; in 1880 it was housed at King's College with very inadequate laboratory accommodation, but later it was removed to Marischal College, where new and extended accommodation was provided. The provision of the new laboratories and other rooms for the natural philosophy department at Marischal College was very largely due to Prof. Niven's initiative and energy, and their successful completion added greatly to the efficiency of the department. When natural philosophy was taught at King's College, only a small number of the students obtained any training in experimental work; with the extended accommodation it became possible to give experimental training to a larger number of students and to a greater extent. Additional lecture courses for students proceeding to an honours degree were also instituted.

In March 1922, Prof. Niven developed a serious illness from which he never fully recovered. He retired from the professorship at the end of September 1922, and his many friends hoped that he might enjoy a period of well-earned leisure, but after a few months free from work he died on May 11.

Mr. E. J. Banfield

THE *Melbourne Argus* announces the death, in May or June last, of Mr. E. J. Banfield, at the age of seventy-one. Mr. Banfield was born in Liverpool on September 4, 1852, and was the son of Mr. J. W. Banfield, of Ararat, Victoria. After having been occupied for some years as a journalist, he retired in 1897, with his wife, to Dunk Island, in lat. 17° 55′ S., between the Great Barrier Reef and the Queensland coast. Here he lived the life of a recluse, occupied in cultivating tropical produce, and in observing Nature, but he found time to describe his experiences in three books, "Confessions of a Beachcomber" (1908), "My Tropic Isle" (1911), and "Tropic Days" (1918).

The "Confessions of a Beachcomber" gives an attractive picture of Mr. Banfield's life on Dunk Island. It describes something of his success in adapting himself to his novel surroundings, alone with his wife except for a few natives, and it reveals him as a man of lovable nature, with a pleasant sense of humour, and as an acute observer of Nature. The book is full of the sunshine and luxuriance of the tropics. In vivid word-pictures it describes the birds which visit some gorgeous tree to feed on its honey or its fruit, the productiveness of the banana or the papaw, the habits of stick-insects or leaf-rolling ants, of dugongs, turtles, and sucking-fish, and many more of the charms of the tropics. Wherever Mr. Banfield records his observations he has something instructive to say; and in many cases his narrative is as entertaining as truthful. He tells us that his retirement was prompted by his wish to put into practical operation his regard for the welfare of bird and plant life. "Man destroys birds for sport, or in mere wantonness, and the increasing myriads of insect hosts lay such toll upon his crops and the fruit of the earth which by the exercise of high intelligence and noble perseverance he has improved and made plentiful, that the national loss is to be counted by hundreds of thousands."

Under Mr. Banfield's rule Dunk Island became a sanctuary for birds, many of which became bold and familiar. He did not hesitate to incur financial losses in order to remain true to his principles. A promising attempt at bee-keeping was relinquished because of the depredations of two species of bee-eating birds, which he would not interfere with in order to save his bees. His death, which took place on the island, was reported by a passing steamer, to which his wife had signalled for assistance. His writings are well worth the attention of zoologists, botanists, and ethnologists, who will find them to contain much that is illuminating and interesting.

S. F. H.

Current Topics and Events.

THE text of the twelfth Huxley Memorial Lecture, delivered recently by Sir Arthur Keith, is published supplementarily to this issue. Its title, "The Adaptational Machinery concerned in the Evolution of Man's Body," admirably defines the greatest of present biological problems, "infinite in extent and complexity," and still affording scope for "many centuries of labour." Such phrases measure the magnitude of Darwin's influence, exerted steadily for over sixty years. The Huxley lecturer, speaking from a vast knowledge of evolutionary biology, says that we know of no means by which the machinery of mechanical adaptation can be altered from without. With Huxley, he believes that the government which rules within the body of the embryo proceeds along its way altogether uninfluenced by occurrences or experiences which affect the body or brain of the parent. The machinery of adaptation has its "predetermined line" of action. We may carp at the word; but Huxley's meaning seems clear enough: he described a sequence in a natural order, not a consequence of a supernatural order. How far we have advanced along the thorny path which the great Darwinians mapped out for us may be judged fairly from the address itself. The question of use-inheritance is crucial; and while every failure to demonstrate its occurrence serves only to establish the Darwinian theory more firmly, there are those who still hope to find in the intricacies of the problem a door of escape from the position assumed by Darwin and Huxley and, we believe, the best and most philosophical workers in biology to-day. Man, even scientific man, does not seem altogether willing to assume his rightful place in the Universe; albeit the place which Darwinism assigns to him is fundamentally securer and philosophically grander than any other which individual or collective wit has designed. We are still far from plumbing the depth of wonder of the Universe of which we are a part, in which we "live, move, and have our being," and the "many centuries" of Sir Arthur Keith that separate us from that aim is a phrase that is good only because it does not bring imagination to a halt. This aspect of the Darwinian theory is still not widely apprehended; none of the natural sciences comes so near to intriguing the personal prejudices of its votaries as biology; but as potent to confuse present work and thought is that sterilising influence of great ideas which, while they liberalise for a time, do so spasmodically. Many workers, all unconsciously, turn from Darwinism because it does for them not too little but too much. Forty, thirty, and even twenty years ago, comparative anatomy and embryology pressed forward irresistibly with Darwinian enthusiasm. During the "many centuries" ahead the present reaction will probably have less significance than appears now; but, for the clarification of present work, Sir Arthur Keith's advocacy is timely.

IN a lecture entitled "Charles Darwin, 1809–1882" delivered to the teachers of the London County Council on March 21, and now published (London: Cambridge University Press, 2*s*. 6*d*. net), Prof. Karl Pearson has brought out with great clearness the importance of the successive revolutions in thought caused by modern discoveries in astronomy, geology, and anthropology, unified as the two latter are by the crowning achievement of Darwin. Prof. Pearson is no doubt justified in attributing the comparatively slow progress of scientific investigation before Darwin to the fact that even among scientific men the date of 4004 B.C. was commonly accepted for the creation of the universe. Many excuses may be offered for this obsession, but it is fair to remember that the date represents only the computation by an Irish Archbishop of the figures given in the existing text of Genesis, and can scarcely be spoken of as having been "fixed by the Church." Perhaps Prof. Pearson is a little too much apt to revive the memory of "old forgotten far-off things, and battles long ago." However, there can be no doubt of the magnitude of the revolution effected by Darwin, a revolution which has made itself felt in every department of human thought. In view of recent occurrences in America, it can scarcely be considered unnecessary to insist once more on the indisputable fact that the doctrine of evolution, thanks to Darwin, is now as thoroughly established as any of the great generalisations of science. Prof. Pearson does well also to emphasise the admirable personal qualities of Darwin.

ABOUT twenty years ago (see NATURE, October 20, 1904, p. 602, and December 15, 1904, p. 156) the performances in Berlin of an intelligent horse—"Clever Hans"—were tested by a committee of psychological experts. The conclusion arrived at was that the performances of the animal, like those of the horse "Mahomet," exhibited in London several years previously, and of performing animals generally, depended chiefly upon observations of movements of the trainer. An experiment carried out by the Marconi Company in connexion with the Zoological Society, at Regent's Park on August 9, supports this conclusion as to the perceptual character of animal thought. The trainer of an Indian elephant at the Society's Gardens spoke to the animal from the British Broadcasting Company's studio, and his voice was distinctly heard in a loud-speaker arranged against the elephant-house. Four orders were given by the trainer, and, though they are always obeyed immediately when he is near, the elephant took no notice of them clearly uttered by the trumpet attached to the wireless receiver. It is possible, of course, that though the words could be heard easily by the people present at the experiment and listening for them, the absence of the trainer deprived the elephant of the associative relation between sound and action. This might be tested by connecting an electrophone with a gramophone record of the trainer's orders, the trainer himself being present but not actually speaking. We should then learn whether an elephant can recognise "His Master's Voice," like the Scotch terrier of the well-known advertisement of gramophones.

FOR the protection of inventions, justification of the patent system is based upon the demands of natural justice and upon economic grounds of pure expediency, a justification which has been recognised in all countries. Similarly for the protection of scientific ideas which are not inventions, justice demands a measure of protection even if expediency speaks with a voice less certain. From time to time, therefore, the cry is raised for protection to be accorded to such important discoveries as do not come within the category of inventions for which patents are obtainable; and now the matter is raised again, this time by the League of Nations. Thus the *Times* for July 30 informs us that the Intellectual Co-operation Commission of the League has decided to submit to the Council and to the Assembly a draft convention for the protection of scientific discoveries. In submitting the draft, the Commission is asking the Governments to establish for scientific discoveries "a copyright similar to that granted for literary and artistic work." What exactly is contemplated by the proposal is far from clear, neither the general idea nor the details having come to hand. If, however, the proposal deals only with the literary expression of a discovery, as might be inferred from the Press notice, it is difficult to see in what way the author of the scientific discovery would in any manner receive benefit. A discovery once published may be expressed in many different ways, such that no one of them need infringe copyright in the others. If the proposal is nothing more, the addition then to the legal systems of nations that it will make will be virtually nil. If, however, it submits a scheme whereby the discoverer of a natural principle or law of world-wide utility may receive a reward commensurate with the importance of the discovery, it is to be welcomed on all hands. Even if the proposal should be found to concern itself only with the literary expression of a discovery, it may yet serve a useful purpose, since it may result in directing public attention once again to the callous neglect of the interests of those to whom the world in the past has been so vastly indebted.

A WEEK of great interest has just ended at Oxford—one of real importance and significance. The seventh International Congress of Psychology has just concluded its meeting there, the last one having been held in Geneva in 1909. For the first time since the War, psychologists from all parts of the world assembled to discuss current problems of psychology. It is mainly due to its president, Dr. C. S. Myers, director of the National Institute of Industrial Psychology, that this result was achieved, and that the entire week passed off so amicably and instructively. The congress was limited to about two hundred members, and included representatives from Great Britain and Ireland, America, Austria, Belgium, Czechoslovakia, France, Germany, Holland, Hungary, Japan, Norway, Poland, Roumania, Spain, Sweden, and Switzerland. They were housed in New College and in Balliol and Manchester Colleges. There were numerous papers and discussions upon scientific and practical aspects of psychology, but no useful purpose would be served merely by recounting their titles. The proceedings opened on Thursday, July 26, with a meeting at which the president made a happy inaugural speech, and a letter was read from Lord Curzon, Chancellor of the University, welcoming the congress to Oxford. A reception was held the same evening in the gardens of New College. On the following afternoon Dr. and Mrs. William Brown entertained the members of the congress at a garden party in the gardens of Worcester College. On Sunday, July 29, the congress listened to a sermon given by Rev. Canon Barnes in the Cathedral, in which he alluded to the way in which science and religion could aid each other. In the afternoon a delightful excursion was made by river to Nuneham, where, thanks to the kindness of Lady Harcourt, the members of the congress were conducted by her and her daughters over the house and grounds. The congress ended in the evening of August 2 with a dinner at Christ Church. Psychologists may feel justly proud at having achieved so much, not only in advancing their own science, but also in promoting peace and goodwill amongst nations generally. About seventy members of the congress paid a visit to Cambridge on Thursday, visiting the Colleges and the Psychological Laboratory, which owes its existence to Dr. C. S. Myers, President of the Congress.

MR. H. SPENCER JONES, Chief Assistant at the Royal Observatory, Greenwich, has been appointed His Majesty's Astronomer at the Cape, in succession to the late Mr. S. S. Hough.

APPLICATIONS are invited from persons possessing an honours degree in electrical engineering or physics, and having experience of electrical research, preferably in the technique of alternating current measurements at high frequencies, for the post of a technical assistant at the Royal Aircraft Establishment, Farnborough. The applications should be addressed to the Superintendent.

THE following awards for the year 1923–24 have been made by the Salters' Institute of Industrial Chemistry, and approved by the Court of the Company. Fellowships are awarded to Mr. T. B. Philip, Imperial College of Science and Technology; Mr. W. G. Sedgwick, Armstrong College, Newcastle-on-Tyne; and Mr. D. T. A. Townend, Imperial College of Science and Technology. Fellowships are renewed to Mr. C. G. Harris, Jesus College, Oxford; and to Mr. J. H. Oliver, Imperial College of Science and Technology. Mr. W. Randerson, a fellow for 1922–1923, having been elected to an Albert Kahn travelling fellowship for the year 1923–24, is made an honorary fellow for the year.

THE Civil Service Commissioners announce that an open competitive examination for not fewer than 12 situations as probationary assistant engineer in the Engineer-in-Chief's Department of the General Post Office will be held in London, commencing on November 6 next. Limits of age: 20 and 25, with certain extensions. Regulations and form of application will be sent in response to requests by letter addressed to the Secretary, Civil Service Commission, Burlington Gardens, London, W.1.

The British Photographic Research Association, which was the first Research Association to be formed under the Department of Scientific and Industrial Research, completed its term of five years in May last. A thorough and searching investigation of the work accomplished has been made by the Department, which has also taken into consideration the researches which are either in progress or are contemplated, with the result that a further grant in aid for a period of years has been promised. Although the financial position of the photographic industry, which is comparatively a small one, is at present at a very low ebb, it is very satisfactory to note that the leaders of the industry are so convinced of the valuable work done by the Research Association, and of the good results which are likely to accrue, that it has been decided to carry on its operations. The Association has had to contend with considerable difficulties during its first five years, but, under the directorship of Dr. Slater Price, it has now a well-established reputation not only in this country, but also in Europe and America. A number of papers dealing with fundamental principles have been authorised for publication in the various scientific journals.

The Maidstone Museum has set a good example to other provincial institutions of this class by issuing a set of post-cards, published at $1\frac{1}{2}d.$ each, illustrating its prehistoric collections. These include a clay bowl attributed to the Bronze Age; palæoliths of the Chellean period; a group of eoliths; some neolithic flint implements—all found in the vicinity. The series also includes a set of good examples of Roman glass.

Our Astronomical Column.

D'Arrest's Comet.—MM. Dubiago and Lexin continue the search ephemeris of this comet (for Greenwich Noon): they use practically the same elements as those deduced by Mr. F. R. Cripps. There is still a prospect of finding the comet, as the greatest surface brightness is not attained until September 12; but the object is in considerable south declination in September and October.

	R.A. h. m.	S. Decl.		R.A. h. m.	S. Decl.
Aug. 24.	17 6·6	9° 8′	Sept. 8.	17 43·1	16° 58′
29.	17 17·5	11 49	13.	17 57·9	19 22
Sept. 3.	17 29·7	14 26	18.	18 13·8	21 34

The Shower of August Meteors.—Mr. W. F. Denning writes:—"The fine warm weather and absence of strong moonlight enabled these meteors to be well observed during the period from August 3-11.

"The display, however, up to the time of writing (August 12) has not been an abundant one, though a fair number of Perseids appeared each night, and the radiant showed its usual displacement to the east-north-east.

"Mr. J. P. M. Prentice, at Stowmarket, recorded the flights of 250 meteors up to August 9, and had recognised a number of the usual minor showers, including α Capricornids, δ and γ Aquarids, δ Cassiopeids, γ and θ Cygnids, Sagittids, ϵ Taurids, $\alpha-\beta$ Perseids, β Piscids, and Lacertids. Mr. Prentice saw a splendid Perseid fireball on August 9, 12h. 32m. G.M.T., with an estimated magnitude greater than that of the full moon. The streak lasted 23 seconds, and its colour was bright blue surrounded by bright red.

"Mr. A. King watched the shower from Lincolnshire on and after August 3, and saw a fair number of Perseids. At Bristol some observations were made on August 4-11, during which period the Perseids were only moderately active. The brightest meteor seen at Bristol was a Cygnid on August 11, 9.40 G.M.T. It was brighter than Jupiter, and traversed a short path from 289° + 66° to 289° + 72°; it left a white streak for a second, across δ Draconis."

Prof. R. Schorr's "Eigenbewegungs-Lexicon."—Prof. Schorr, director of Bergedorf Observatory, Hamburg, has just brought out a very useful work of reference in the form of a comprehensive catalogue of practically all the known proper-motions of stars. It is arranged in zones of declination, 1° wide, the designation of the stars being taken from the Durchmusterungs of Bonn, Cordoba, and the Cape. It is numbered by columns (two to a page) and there are 400 columns, each containing some fifty stars. Only one determination is given of each motion, presumably the best available; the authorities are given in each case. The centennial motion is given to two decimals of a second of time in right ascension, and one decimal of a second of arc in declination; a few stars are given to one figure less than this.

To diminish cost the work was typewritten, and then multiplied by a mechanical process, the result being perfectly clear and legible. The price is fixed at thirty Swiss francs.

Already a first supplement has appeared, containing 1739 stars; some of these, marked "!," are improved values for stars already in the Lexicon, but the majority are additional stars.

This is the second very useful work that Prof. Schorr has issued in a few months, his new reduction of Rümker's Hamburg Catalogue having lately appeared (Nature, April 28, p. 564).

The Free Pendulum.—Mr. F. Hope-Jones delivered a lecture on this subject to the British Horological Institute on April 19, and it has lately been issued as a pamphlet. He lays stress on giving the pendulum that we rely on as primary time-keeper as little work to do as possible; his three desiderata are: (1) the maintaining impulse must be given at the zero (lowest) position; (2) it must only be given occasionally; and (3) there must be no other interference with the pendulum.

Mr. Hope-Jones states that this problem has been solved, quite independently, by five men in the last twenty-five years: Mr. Rudd in 1898, Sir David Gill in 1904, Mr. Bartrum in 1913, Father O'Leary, S.J., during the War, and Mr. W. H. Shortt, who has been at work since 1911 on the matter, his clock being installed at Edinburgh Observatory early in 1922. The details of each of the five methods are briefly given, but the last is considered much the best. The fundamental pendulum, constructed of invar, is in an air-tight case, pressure 3·5 cm., kept at constant temperature. It receives its impulse every half-minute, at the lowest position; the remontoire is worked by the slave-clock, which is synchronised by a "hit or miss" action to within 0·01 second. Two diagrams of the changes of weekly rate in periods of three months are given; the range of weekly rate is 0·02 second per week. Prof. Sampson notes that the clock is superior to the Riefler instrument, though that is a very fine clock.

A clock with uniform rate is of great importance in fundamental astronomy for the removal of the small systematic errors in right ascension; they have been greatly reduced, but not wholly removed.

Research Items.

The Swiss National Park and its Mollusca.—First mooted in 1906, a National Park for Switzerland was finally established in January 1919. It is situate in the Lower Engadine, almost on the extreme eastern border of Switzerland, and abutting on the Italian frontier. It comprises an area of about 151·5 sq. km., and has been put in the charge of a Commission, which has wisely decided on a complete investigation of its fauna, flora, etc., a task which the Schweizerische Naturforschende Gesellschaft has undertaken to carry out. For the purposes of this survey, however, it has been resolved to include the territory to the north of the Park down to the banks of the Inn, as well as some to the east, so as to furnish a more satisfactory physical area to deal with as a whole. The first portion of this undertaking, the "Molluscan Fauna," by Ernst Bütikofer, has just been published by the Schweizerische Naturforschende Gesellschaft in Bd. lv. of their Denkschriften. If this be a fair sample the complete work will be well worthy of its authors. Following a general account of the characters of the eleven districts into which, for purposes of description, the district has been divided, come the molluscan fauna of each, a systematic description of the various species and varieties, with tables of their horizontal and vertical distribution, and an excellent bibliography. Close on eighty forms, if we include those in the appendix, are dealt with, and the photographs of shells are mostly particularly good.

Protozoa and Potato Mosaic.—As recently reported in Nature (July 21, p. 111), Ray Nelson has reported in America that a protozoal organism is associated with the phloem of potato plants affected by the disease known as mosaic, which is usually grouped among the "virus" diseases in which the causal organism is assumed to be ultra-microscopic. The July issue of *Phytopathology*, the journal issued by the American Phytopathological Society, contains no less than four brief papers, with which the names of seven investigators are associated, all pointing out that the structures described by Nelson are also present in the phloem of Solanaceous plants which are not affected by mosaic but, so far as can be determined, are perfectly healthy. There seems to be little doubt that Nelson has redescribed and photographed peculiar protoplasmic inclusions, present in the phloem of some Angiosperms but not in all, and which, as Irving W. Bailey and other writers point out in *Phytopathology*, are probably identical with the "slime bodies" described by Strasburger (in 1891) in the phloem of *Robinia Pseudacacia*. These "slime bodies" do not seem to be identical with nuclei, though they often are seen in contact with them. Ernst W. Schmidt, in his recent monograph upon the Angiosperm sieve-tubes (Jena, 1917), concluded that the nucleus was typically present in the Angiosperm sieve-tube. Possibly this recent American rediscovery of these other cytoplasmic inclusions will lead to a re-exploration of the cytology of the sieve-tube, a subject which would seem to be by no means exhausted.

Poplars.—Forestry Commission Bulletin No. 5, just issued by H.M. Stationery Office, price 1s. 6d., is a remarkably full account of the different poplars which are suitable for the production of timber on a commercial scale in Great Britain. The first chapter, due to Prof. A. Henry, is concerned with their botanical description, and is illustrated with two plates, showing clearly the distinctive characters of the twigs and leaves of the twelve important species and hybrids. The second chapter, by Mr. W. H. Guillebaud, who specially investigated the growth of poplars in the north of France, is devoted to silviculture, and discusses fully propagation, planting, thinning, pruning, rate of growth and yield. In the third chapter, Dr. J. W. Munro deals with injurious insects and Mr. W. E. Hiley with fungi and bacterial diseases. The last chapter, by Mr. W. H. Dallimore of Kew, is an admirable account of the character and uses of poplar wood, and should prove of great interest to both landowners and manufacturers, as the use of home-grown poplar timber is capable of great extension. For example, the wood of aspen is indispensable for the match industry, and has hitherto been mainly imported from Northern Russia. The recent plantation on a large scale of this tree in Argyllshire by Messrs. Bryant and May indicates that supplies of aspen timber from abroad at a reasonable price cannot in the future be depended upon.

Upper-Air Observations in North Russia.—A Professional Note, vol. 3, No. 32, carried out by Mr. W. H. Pick, has been published on the above by the Meteorological Office, Air Ministry. The observations are based upon pilot balloon ascents between February 25 and September 13, 1919, at three stations in north-west Russia. The stations are Murmansk, at the head of the Kola Creek, in latitude about 69° N., Archangel on the south-western coast of the White Sea, in latitude 64° 33′ N., and Lumbushi on the Murman Railway, in latitude about 68° N. The ascents were all carried out with one theodolite only, the balloon being given a vertical lift of, theoretically, 500 ft. per minute. The high latitude in which the observations were obtained renders them of value. There were at Murmansk 57 occasions on which the surface wind was in the north-east quadrant, and on 10 of these—that is, 17·5 per cent. of the total—the wind backed continuously up to 2000 feet. On the other hand, there were 164 occasions on which the surface wind was not in the north-east quadrant, and in only 5 of these—that is, 3·0 per cent. of the whole—did the wind back continuously upward. At Murmansk three ascents reached to a height of 40,000 feet, where two of the winds were N.W. and one S.W. Two ascents reached to 60,000 ft., where both winds were S.W. Seven ascents reached 20,000 ft., at that height four of the winds were S.W. and two N.W. Of the ascents carried out at Archangel only one reached 20,000 ft., where the wind was southerly. Of the ascents at Lumbushi, six attained a height of 20,000 ft., giving two north-westerly winds, three north-easterly, and one southerly.

The Climate of Khartoum.—Physical Department paper No. 9, prepared by Mr. L. J. Sutton, has recently been issued by the Ministry of Public Works, Egypt. The discussion deals with the meteorology of Khartoum, which place was installed as a second-order station in 1900, and is approximately 390 metres above sea-level. Maps of isobars are given for the several months which show the normal distribution of pressure over the surrounding region, which is of great help in following the changes of weather conditions which occur at Khartoum in the different seasons. It is during the period from the middle of June to September that the weather conditions are most disturbed. Thunder-storms and *haboobs*, or storms of wind, are frequent, and the short rainy season is experienced. In October to May there is

an entire absence of rain. The observations are discussed for the period of twenty-two years, from 1900 to 1921. Atmospheric pressure varies very regularly throughout the year; a minimum is reached about the beginning of May, and a second minimum occurs about the beginning of October. The diurnal range of the barometer is very regular and does not vary much in the course of the year. The coldest month is January, with a mean temperature of 22°·5 C.; the warmest month is June, with a mean temperature of 34°·1 C. The short rainy season causes a second minimum, 31°·2 C. in August. The second maximum temperature occurs about the end of September, approximately, the same time as the second minimum of pressure. Diurnal range of temperature is greatest, 14°·5 C., in April, and least, 10°·1 C., in September. Statistical values are also given of humidity, vapour pressure, cloud, sunshine, wind, and the upper winds. The amount of rainfall is small, averaging only 148 mm., or rather less than 6 in. for the year; nearly 90 per cent. of this falls in July, August, and September. The discussion will serve as a specimen for other stations.

Goldfields of Western Australia.—The Department of Mines of Western Australia has issued an important description of the gold deposits of Western Australia, written by Mr. A. Gibb Maitland. The author classifies the gold-bearing deposits under the following five heads: 1. Simple or fissure veins, carrying auriferous quartz with or without accessory minerals. 2. Composite veins or lodes, which are made up of a number of more or less parallel lenticular veins. 3. Sheeted zones, consisting of a series of closely spaced and parallel veins, generally of small dimensions. 4. Stockworks, which are irregular networks of small auriferous quartz veins. 5. Shear zones or bands of schistose rocks, impregnated with various sulphides, iron pyrites often predominating, and containing little or no quartz. In addition to the above classification, the author, when discussing the individual goldfields, also mentions the so-called "lode formations," which he defines as "impregnations of zones of previously existing rocks and confined largely to shear zones, characterised by much crushing and fracturing as well as the deposition of quartz along such fractures." It would appear that such lode formations are especially important in the Boulder and Kalgoorlie districts of the East Coolgardie gold-field, which is itself by far the most important of the Western Australian gold-fields, having produced over 17 million ounces of gold out of a total of 31 million ounces produced by Western Australia, whilst no other individual goldfield has produced above 3 million ounces. The gold production of Western Australia reached a maximum in the year 1903, when the output was just above 2 million ounces; since that time it has been gradually declining, until in 1918 it was only 876,511 ounces, but the account here published shows that there is good reason to hope that the present output may be reasonably expected to be maintained for a considerable time to come.

The Earth's Magnetic Field.—In the issue of *Terrestrial Magnetism and Atmospheric Electricity* for March-June, Dr. L. A. Bauer gives the chief results of a preliminary analysis of the earth's magnetic field for 1922 based on the British Admiralty magnetic charts for 1922 and those of the United States Hydrographic Office for 1920 corrected to 1922. He finds that the field at any instant is compounded of an internal field having a potential and representing about 94 per cent. of the total, an external field also having a potential and a non-potential field of about equal strengths. The time change of the field is equally complex. On the whole, during the past 80 years the north end of the axis of the internal field has moved slowly towards the west and south, and the intensity of magnetisation has decreased at the rate of 1/1500 of itself per annum. The intensity over land areas is greater than over ocean areas in the same latitude, and the decrease during the past 37 years greater over ocean parallels than over land parallels of latitude.

Production of Smokeless Fuel.—A pamphlet entitled "The Story of the Scott-Moncrieff Retort for producing Smokeless Fuel," printed by Moultons (Printers) Ltd., Brighton, contains material of some historical interest in connection with the efforts which have been and are being made to solve the problem of the low-temperature carbonisation of bituminous coal for the production of smokeless fuel. It deals with the recent and pioneering efforts (dating back to 1870) of Mr. W. D. Scott-Moncrieff. Since 1921 he has been engaged in experiments made at the Newhaven Gas Works in order to perfect a retort for which "final success" is claimed. In an enclosed analytical report are given tables of results of carbonisation trials which seem typical of those to be expected from the carbonisation of Durham and Yorkshire coals at temperatures about 600° C. The fuel produced is stated to be "smokeless and suitable for transit," and the "results exceed all expectations." Insufficient evidence is adduced to enable the reader to judge the validity of these claims. One can only await with interest the appearance of further details, with the hope that, if a solution has been found of a problem which has proved so baffling, both on the technical and the economic sides, credit will fall to one of the pioneering workers.

Oxidation of Carbon.—The well-known method of oxidation of organic substances by a mixture of chromic and sulphuric acids has been recently re-examined by J. L. Simon, and the results, some of which were unexpected, have been communicated in a series of notes to the *Comptes rendus* of the Paris Academy of Sciences. With the usual mixture of potassium bichromate and sulphuric acid some compounds are completely, others only partially, oxidised. The substitution of silver bichromate for potassium bichromate in the mixture was found to give complete combustion in some cases where the classical mixture gave only partial oxidation. Interesting and unexpected results were obtained on applying these two mixtures to the oxidation of the various forms of carbon. Pure graphite, using the silver oxidising mixture, was completely oxidised to carbon dioxide (with a trace of carbon monoxide) in half an hour at 100° C.: in the absence of silver the combustion was partial, from 66 per cent. to 72 per cent. being burnt. In a later communication (July 23) it is shown that the deficit in the absence of silver is related to the constitution of the compound, and the aromatic compounds can be clearly distinguished from others by the different figures given by the two reagents. As regards the different forms of carbon: in the presence of silver, graphite is completely burnt, diamond is not oxidised at all, while for various forms of charcoal, coke, and coal, only from 1 per cent. to 6 per cent. is burnt. The fact that it is possible to oxidise graphite by thirds is in agreement with the view of a hexagonal distribution of the carbon atoms, and there is a marked experimental difference between graphite and certain varieties of black carbon which it is natural to attribute to a difference in constitution.

Fossil Human Bones, possibly of Pleistocene Age, found in Egypt.

AT a meeting of the Royal Anthropological Institute, held on July 17, Prof. C. G. Seligman, president, in the chair, Dr. D. E. Derry described the fossilised human bones recently discovered in Egypt, which, on the ground of their condition, he is inclined to regard as of Pleistocene age. The discovery is one of very considerable importance, as this is the first occasion on which fossilised human bones have been obtained from Egypt. Early in January of the present year Mr. Guy Brunton, while excavating for the British School of Archæology in Upper Egypt, found at Gau-el-Kebir, on the east bank of the Nile, about thirty miles south of Assiut, a remarkable collection of bones, mostly animal, but with pieces of human bones mixed with them in the heap. Some of the bones, including the human fragments, were heavily mineralised, while others were only partially so, and some not at all. The whole collection was contained in an Early Dynastic grave, and had obviously been placed there for some purpose. Among the bones were carved bone and ivory objects of the XIXth Dynasty. The presence of the latter is explained on the assumption that this was the site of a workshop for the manufacture of articles in bone and ivory, and that the great heap dumped into the pit of an early grave represented the workman's material. The presence of freshwater oyster shells attached to some of the bones proves that they came from the river, or, what is more likely, from a swamp fed by the river, which in all probability was much nearer the site of the discovery than it is now. The bones exhibit evidence of having been exposed for a long time to the mineralising influence, as they are very heavy, black, and highly polished, probably from the friction of waterborne sand.

The first evidence of human fossil bones in the heap was found by Mr. Brunton. This consisted of the right half of a frontal bone. Afterwards the whole heap, probably about two tons of bones, was gone through and several other fragments both of skulls and limb bones were recovered. Pieces of three skulls were found, as well as part of a mandible. Fragments of hip bones, upper and lower limb bones, and an axis vertebra were also obtained. Two skulls are represented only by the frontal bone of each. These are remarkable for their small size and shallowness, with consequent small brain capacity. The third skull consists of the whole right parietal bone with a large part of the left parietal, welded into one piece. As it stands this appears to have been a well-shaped head with a maximum cranial breadth of 143 mm. This fragment is, however, much more heavily mineralised than the two frontal bones, which would appear to have belonged to a more primitive race. Some very unusual anatomical features are exhibited by the mandibular fragment and also by the piece of a right ilium.

The position in which the bones were found precludes the possibility of assigning them to any geological period; but an examination of the animal remains by Prof. Watson has revealed the presence of at least two extinct animals, a crocodile and a buffalo, both of Pleistocene date, while the mineralisation of the human fragments is as extensive as that of any of the animal remains.

In the discussion which followed the reading of the paper, Sir W. M. Flinders Petrie pointed out that in regard to the dating of the bones it must be remembered that owing to the constant and consistent deposit of mud by the Nile, amounting to about 3½ ft. in a thousand years, the bed of the river was rising continually. Any object deposited while the Nile was thus rising would be lost irretrievably beneath the mud. These bones must therefore have been deposited while the Nile was falling from six hundred feet above to one hundred feet below its present level. The date of deposition must therefore be at least 15,000 years ago, plus the time occupied by the fall of the river to the level of the swamp which had been postulated as the place of deposit.

Sir Arthur Keith said the discovery was extraordinarily interesting and puzzling. These fossilised bones, the first to be found in Egypt, presented no outstanding features marking them off from modern man, and no diagnosis of race was possible, but this did not preclude their high antiquity, and they might well be Pleistocene. Fragments of hippopotamus bone from the Nile mud, now at South Kensington, exhibited staining and a high polish exactly similar to that of some of Dr. Derry's specimens. Sir Arthur laid stress on the importance of the fringes of the great desert belt as the possible site of the evolution of our race; Dr. Derry's discovery, though we could not place it exactly, was of the first importance. Probably men of our type existed in Egypt more than 18,000 years ago, and populated Europe, possibly more than once. Prof. Seligman said the cubic capacity of 1040 c.c. of the small skull suggested a comparison with the smaller skulls from the Thebaid described by Dr. Randall-MacIver, and, in conjunction with the steatopygous predynastic figures discovered by Sir W. M. Flinders Petrie, pointed to the necessity of a further comparison with Bushmen skulls.

Recent Fisheries Investigations.

SOME very interesting reports, in continuation of Series II. (Sea Fishery Investigations), have recently been published by the Ministry of Agriculture and Fisheries. No 6 of vol. 4 is written by Mr. J. O. Borley, and describes the samples of bottom deposits collected in the southern North Sea by the vessels of the Marine Biological Association. The report is illustrated by charts and many very beautiful photographs. The deposits are graded in various ways, partly by mechanical sieving and partly by a method of levigation, and the results show a correspondence between the average sizes of the particles and the transporting power of the current systems. In general the particles are coarsest where the tidal streams are most rapid, and *vice versa*. It is not improbable that there is attrition of particles on the sea bottom, but this cannot be very great. At 20 fathoms (that is, not far from the average depth of the North Sea) the currents are competent to grade bottom materials: at this depth wave action on the surface has a notable effect at the bottom.

No. 1 of vol. 5 is a summary of very extensive market statistics, collected in regard to the cod, during the years 1913–14. No. 2 of vol. 5 is highly important. It is written by Mr. H. J. Buchanan-Wollaston, and deals with the spawning of the plaice in the southern North Sea (the Flemish Bight) during the years 1913–14. The method is an extension of the Hensen quantitative plankton one, but novel and beautifully manageable mathematical methods of dealing with the results have been developed: some of these are highly ingenious, and have, perhaps,

application to problems other than those for which they have been devised. The results are interesting almost to the degree of being "sensational." In January of 1913–14 the rate of production of plaice eggs over the whole area sampled was 180,000 millions per 3 days, and in February the rate dropped to 157,000 millions per 3 days. That works out at about two million million eggs per month and about five million million per year. To produce these eggs some twenty millions of female plaice at least must have been required. The rate of mortality is very high, and only about 10 to 30 per cent. of the eggs hatch out. The production was far higher in 1914 than in 1911.

No. 3 of vol. 5, written by Mr. J. O. Borley and his collaborators, deals with the plaice fisheries during the war years, and discusses the results of the special investigations made in various parts of the British sea-fishery area. The report and recommendations of the plaice committee of the International Fishery Council are appended.

No. 4 of vol. 5 breaks entirely new ground so far as the British sea fisheries are concerned. It is an account of the various kinds of gear now used in sea fishing in England and Wales, and has been written by Mr. F. M. Davis. The descriptions are clear; the drawings are very well done, and the Report represents a vast amount of very careful local investigation.

J. J.

The Floor of the Valley of Ten Thousand Smokes.

THE amazing display of fumarole action over an area of some fifty square miles, which arose in association with the volcanic outbreak of Mt. Katmai in Alaska in 1912, was described and illustrated by its discoverer, R. F. Griggs, in NATURE, vol. 101, p. 497 (1918). In 1920 (vol. 104, p. 595), J. W. Shipley, of Winnipeg, chemist to the first Katmai expedition, gave an illustrated account of the "great mud-flow" through which the vapours fume, and he attributed the material to an eruption of Mt. Novarupta, preceding that of Katmai. He concluded that the spreading of the volcanic dust and scoriæ down the valley towards the Bering Sea was assisted by rains, and that heat from below had hardened the surface and produced the cracks that traverse it.

The National Geographic Society, which organised the expedition led by Dr. Griggs, has now begun the publication of a series of scientific memoirs on special features of the district, following on the general description that was noticed in NATURE, vol. 111, p. 269 (1923). No. 1 of the "Katmai Series" of contributed papers is on "The Origin and Mode of Emplacement of the great Tuff Deposit of the Valley of Ten Thousand Smokes," by the well-known petrologist Clarence N. Fenner, of the Geophysical Laboratory of the Carnegie Institution of Washington.

The author finds, from a thorough study of the valley-floor, that the tuff was erupted from a large number of vents that opened along fissures mainly occurring in the lowland, and that these fissures determine the present lines of fumaroles. The fragmental material flowed while hot enough to char all vegetation in its path; no doubt it was still liberating gases, and the phenomena of Mount Pelée of Martinique were repeated. Katmai exploded somewhat later, since its ashes rest upon the volcanic detritus connected with the fumaroles.

Most of this detritus consists of highly siliceous glass, which has caught up basic matter from older igneous rocks; the mixed blocks possibly come from the moraines around Novarupta, the cone of which is formed of a soda-rhyolite that has penetrated and mingled with a dark medium andesite (p. 56 of memoir). But the author regards it as more likely that similar rock underlies the valley generally. Jurassic sandstones and shales have been blown to fragments by the explosions in the valley-floor; but the source of the andesitic admixture has not been traced here or at Novarupta.

Dr. Fenner's conclusion is that a sill of igneous rock penetrated the sedimentary series beneath the valley, burst into explosive activity along the cracks that opened, and deluged the country with fragmental matter that continued to give off gases and to spread as a quasi-liquid towards the coast. The numerous beautiful photographs accompanying his contribution, including several of Novarupta, complete its value as a petrological study carried out mainly in the field. We may now regard the Valley of Ten Thousand Smokes as one of the finest examples of the uprise and emanation of magmatic waters, and as a further reminder that igneous rocks as they reach us in hard specimens are something very different, both chemically and physically, from their representatives in the cauldrons of the crust.

GRENVILLE A. J. COLE.

Cultivation of Metal Crystals by Separation from the Gaseous State.

F. KOREF describes experiments on the deposition of crystalline tungsten on a wire consisting of a single tungsten crystal, which is heated electrically in a mixture of hydrogen and tungsten hexachloride vapour in an electric oven.[1] When the oven is fairly cool (about 110° C.) and the pressure is kept down to 12 mm. of mercury, the wire being raised to 1000° C., the metal deposits in crystalline form, growing from the unit crystal, so that the dividing line between the two is scarcely visible in a magnified section, which, when etched, shows the characteristic structure of a tungsten crystal. The external form shows more or less distinct crystalline surfaces and edges, though the surfaces are not perfectly plane, being sometimes concave cylindrical, while the edges are not always sharp. It is concluded, however, that the whole mass forms one crystal, which has grown from the original crystal wire. The number of bounding surfaces seems to depend on the direction of the crystal axis in the original wire, the prism being four-, six-, or eight-sided. The diameter can be increased from 0·05 to 0·15 mm., the temperature being kept constant during the deposition by regulating the heating current.

Although the original wire is flexible the crystal grown from it is brittle; but it becomes flexible after being heated for a few minutes to 2500° C.; no difference in the structure can be observed after this annealing, either microscopically or by X-ray examination. Burger has made a similar observation on tin crystals, obtained from molten tin. Apparently the atoms do not alter their positions during the heat treatment; but in some way, possibly by rotations about their centres, come into new relative relations to one another, and link together more perfectly to form a stronger and more flexible whole.

If the attempt is made to cultivate the crystal beyond the dimensions given above, the surfaces become deformed by the growth on them of numerous small pyramids, the molecules (atoms) no longer

[1] *Zeit. Electrochem.*, 28, pp. 511-517, December 1, 1922.

taking their places in regular fashion on the surfaces of the original crystal; but aggregating themselves about certain minute elementary crystals formed on the surface, which act as "buds" about which further growth takes place. When the pressure and temperature of the oven are high, this takes place from the commencement, and there is no regular crystal growth; but a deposit is formed in scaly layers round the original wire, which is either spongy or dendritic in character.

At the correct temperature and pressure the wire will continue to grow as a single crystal in spite of preliminary deformations, such as twisting, winding into a helix, or even drawing through a die. An attempt was made to draw down the annealed cultivated crystal into a fine wire, in the hope that further cultivation would be possible upon it; but this failed owing to the fact that the whole pressure coming on the edges overloaded the structure. The resulting wire no longer formed a single crystal; and when additional tungsten vapour was deposited on it, each of the small crystals of which it was composed grew independently; the resulting wire was brittle, and could not be made flexible by heating. A similar result was obtained with an ordinary tungsten wire, which did not consist of a single crystal; in this case it was found that heating to 2500° C. for fifteen minutes caused a great many of the small crystals formed at first to unite, so as to give a much coarser structure. This welding of small into larger crystals, without mechanical pressure, has not, apparently, been previously observed.

State Afforestation in 1921–22.[1]

THE Forestry Commissioners, who have just issued their third annual report, were appointed in November 1919, to carry out a definite programme of afforestation, involving the planting of 150,000 acres of new land in the ensuing ten years, the cost to be defrayed from the Forestry Fund, a sum of 3,500,000*l*. voted by Parliament for the whole period. Acquirement of land, planting operations, and other activities, including education and research, were proceeded with according to plan during the first two years; but the unfavourable financial position of the Government necessitated a reduced programme in the third year, so far as expenses were met with out of the Forestry Fund. Fortunately the Commissioners obtained a large grant out of the Unemployment Fund, and their operations have practically not been restricted. During the year ended September 30, 1922, the Commissioners expended 244,414*l*. out of the Forestry Fund, and 154,017*l*. out of the Unemployment Fund, in all 398,431*l*., a sum in excess of the normal programme.

The new land acquired for State afforestation during 1921–22 amounted to 23,937 acres. The Commissioners now possess 92,426 acres of plantable land. The area planted by the Commissioners in the year was 10,693 acres; and in addition to this, 10,192 acres were planted by private owners and corporations by means of grants, which were given on condition that unemployed labour should be used. These figures are very satisfactory. The usefulness of forestry for relief work is abundantly shown in the report, which is replete with statistics of the areas and species in the various plantations and nurseries.

Grants in aid of higher forestry education, in all 2206*l*., were given to the University schools at Oxford, Cambridge, Bangor, Armstrong College, and the two Agricultural Colleges at Aberdeen and Glasgow. The Commissioners have now three schools for training woodmen, at Parkend (Forest of Dean), Chopwell (Co. Durham), and Beauly (Inverness-shire), at an annual cost of 10,160*l*. On research and experiment, the expenditure was 6126*l*. Experimental plots of various species of trees are now 120 in number. Investigations are being carried out in regard to Chermes, *Phomopsis Douglasii*, tree growth on peat, larch hybridisation, etc.; and a census of woodlands is in progress.

[1] Third Annual Report of the Forestry Commissioners. Year ending September 30, 1922. (H.M. Stationery Office, 1923.) Price 1*s*. net.

The British Medical Association.

THE meeting of the British Medical Association at Portsmouth began on July 20, and the address of the president, Mr. C. P. Childe, was given on the evening of July 24 to a large audience, among whom were a number of distinguished visitors largely from the Oversea Dominions. The president in his address made a strong plea for better housing conditions in the industrial centres, and insisted that an enormous amount of the time and money which is at present being spent on the treatment of diseases like rickets and tuberculosis could be saved if adequate care were given to the housing problem, for in his opinion the absence of fresh air and sunlight in many of the crowded industrial centres was in itself largely responsible for the widespread occurrence of these diseases.

The detailed work in the sixteen different Sections went on from July 25 to July 27, during which a very wide field of subject was under discussion.

In the Section of Pathology and Bacteriology there were discussions upon diseases of the stomach and their methods of investigation, by Dr. C. Bolton; the value of serological tests in diagnosis, by Prof. H. R. Dean; and one on the part played by fungi in disease, by Dr. Castellani. Demonstrations were given, in the afternoons, of specimens which had been collected, forming a museum of very great interest.

In the Section of Radiology a discussion was opened by Dr. R. W. Salmond on the X-ray examination of the urinary tract. During the discussion it was evident that different weight was given by radiologists to the value of screen examinations of the region of the kidney.

The second subject for discussion in this Section was that of medical diathermy, opened by Dr. E. P. Cumberbatch, and followed by Dr. C. A. Robinson, who gave a detailed account of the treatment of gonorrhœa by means of diathermic currents; the temperature which can be tolerated by the tissues is sufficiently high to cause the death of the causative micro-organism, and beneficial results ensue.

In the Section of Tuberculosis a discussion was opened by Prof. Reyn, of Copenhagen, on the subject of the artificial light treatment of lupus and other forms of tuberculosis. From the clinical investigations which have been continued during a large number of years at Copenhagen, the conclusion has been reached that the results obtained in the treatment of lupus by means of ultra-violet light, initiated there by Finsen, are much improved if the local intensive treatment is supplemented by a general irradiation of the whole body. Dr. Sequeira reported a similar result from his experiences at the London Hospital; Prof. Russ thought that it was now possible to assign to certain parts of the spectrum their particular function in this form of therapy, and if this were the case selection of the best form

of radiation source became an important consideration.

The social aspects of tuberculosis were discussed in this Section as well as in that of Public Health.

A large exhibition was organised representing practically every aspect of medical work. This was supplemented by additional exhibits of interest to special Sections, such as radiology, pathology, parasitology, anatomy, etc., but considerations of space do not allow of more detailed notice here.

The meeting was very largely attended. The work of the local committees resulted in a very wide choice of excursion to the visitors, which was highly appreciated by them.

Einstein and the Philosophies of Kant and Mach.

THE Bulletin de la Société Française de Philosophie for July 1922, which has just been published (Armand Colin, Paris), contains the report of the reception of Prof. Einstein in Paris on April 6, 1922. It is of exceptional interest, for Einstein did not make an original communication, but assisted at a discussion of the theory of relativity.

Prof. Langevin introduced the discussion, and Messrs. Hadamard, Cartan, Painlevé, Perrin, Becquerel, Brunschvicg, Le Roy, Bergson, Meyerson, and Piéron took part. It elicited from Einstein two pronouncements of special significance in regard to the relation of his theory first to Kant and secondly to Mach. We quote them in full. The first was in reply to M. Brunschvicg, who had said that the Kantian philosophy in separating a *container*, space and time, from a *content*, matter and force, had ended in antinomies, while Einstein's conception, which is characterised by the fact that *container* and *content* are inseparable, had delivered us from them. To this Einstein replied: "I do not think my theory accords with the thought of Kant, that is, with what that thought appears to me to be. What appears to me the most important thing in Kant's philosophy is that it speaks of *a priori* concepts for the construction of science. Now there are two opposite points of view: Kant's apriorism, according to which certain concepts pre-exist in our consciousness, and Poincaré's conventionalism. Both agree on this point, that to construct science we need arbitrary concepts; but as to whether these concepts are given *a priori* or are arbitrary conventions, I am unable to say."

The second pronouncement was in reply to M. Meyerson, who had challenged him to declare how far he was in agreement with the theory of Mach. Einstein replied: "There does not appear to be a great relation from the logical point of view between the theory of relativity and Mach's theory. For Mach, there are two points to distinguish: on one hand there are the immediate data of experience, things we cannot touch; on the other there are concepts which we can modify. Mach's system studies the existing relations between data of experience; for Mach, science is the totality of these relations. That point of view is wrong, and, in fact, what Mach has done is to make a catalogue, not a system. To the extent that Mach was a good mechanician he was a deplorable philosopher. His view of science, that it deals with immediate data, led him to reject the existence of atoms. Probably were he still with us he would change his opinion. I would like to say, however, that on the other point, namely, that concepts can change, I am in complete agreement with Mach."

The Life-Cycle of the Protozoa.

PROF. C. A. KOFOID delivered, on December 27 last in Boston, an address as vice-president of Section F (Zoology) of the American Association for the Advancement of Science and as president of the American Society of Zoologists, on the life-cycle of the Protozoa (*Science*, vol. lvii. pp. 397-408, April 6, 1923). He remarked that the striking similarities of the most ancient fossil Protozoa to recent afford some ground for the inference that the Protozoa living to-day differ but little from those when life was young. A consideration of the accounts of the origin *de novo* of nuclei from chromidia leads to the conclusion that adequate evidence of such origin is lacking. Prof. Kofoid holds that, as sound cytological investigation of the Protozoa progresses, it becomes increasingly evident that the descent of the nuclei and the individuality of the chromosomes, found in the Metazoa, holds also for the Protozoa, and it may be inferred that the Protozoa are equipped with the essential structural basis—chromosomes and mitosis—for the mechanism of heredity.

The searcher for the origins of biological phenomena finds in the Protozoa a fertile but perplexing field. Here have arisen all the fundamental types of symmetry—spiral, leiotropic, dexiotropic, radial, bilateral, and modifications of these. Here also are several distinct types of mitosis, different locations of the centrosome, and extraordinary derivatives of this organ ranging from the nematocysts of Dinoflagellates to the complicated neuromotor system of the trichonymphid flagellates. Sex and sexual dimorphism have also had their origin in the Protozoa. Prof. Kofoid also refers to the universal occurrence of asexual reproduction in the Protozoa, and to the development after fertilisation of a multicellular stage, which he terms a somatella, in which there is generally no progress to the point of division of labour and differentiation of tissues, although the differentiation of sexual and somatic cells occurs in some cases, *e.g.* Volvox. The sequence of events within the cyst of Entamœba—involving elaboration of glycogen and the formation of the chromatoidal substance with its relation to the growth processes—is regarded as suggestive of the sequence in the egg and of the relationship of specific yolk substances to cleavage and differentiation in the metazoan egg. The observations of Jameson on maturation in the Sporozoa show that the haploid condition persists throughout the period of growth and asexual reproductions, while the diploid lasts but one cell-generation. Such conditions give occasion to wonder whether or not sexual reproduction may not have been elaborated gradually and independently within widely different groups in the Protista, and afterwards in them and in higher forms of life the diploid state has extended its domain more and more throughout the life-cycle.

Prof. Kofoid considers that the life-cycle of the malaria parasite—the zygote, the multicellular stage which follows and leads to the formation of sporozoites, which on introduction to man undergo growth and asexual reproduction to form merozoites, and the eventual production of gametocytes—may be compared with the fundamental processes of fertilisation, cleavage, asexual reproduction, and gametogenesis in the Metazoa, except that histogenesis and organ differentiation do not appear. He believes it may perhaps be helpful and serve to facilitate progress if we emphasise the similarities of organisms and seek to find the common processes underlying them all, rather than to emphasise their differences and thus obscure our vision of fundamental problems of life.

Science in Poland.[1]

IN 1881 the Mianowski Institution was founded at Warsaw with the object of promoting the interests of science in Poland. During many years the Institution had to struggle with the suspicious hostility of the Russian Government; notwithstanding bureaucratic cavil and quibble, the Institution edited between 1881 and 1916 more than 1000 volumes of scientific publications (originally written in Polish or translated), assisted hundreds of Polish scientific men in their work, subsidised various laboratories and research institutes, and accomplished much other valuable scientific and national work.

In 1918 and 1919, as soon as Poland was free, the influence and activity of the Institution expanded in a most satisfactory manner. In 1920 a meeting of 533 Polish men of science, coming from all parts of the country, was held at Warsaw, under the auspices of the Institution, with the object of considering, from various points of view, the needs and claims of science in Poland and the immediate prospects of intellectual development of the country. Volume 3 of "Nauka Polska" contains most of the addresses delivered at the Congress. It deals, of course, with many subjects treated by different writers in a variety of tone and of style; it is impossible, however, not to be struck with the glowing patriotic enthusiasm and the noble attachment to the cause of science shown in its pages.

In the inaugural address Prof. Jan Rozwadowski, professor of comparative linguistics in the Jagellonian University of Cracow, takes an uncommon and highly interesting view of "Science and Life." Prof. Rozwadowski would almost suggest that even science may countenance much that is superficial, futile, irrelevant, and sometimes even insincere. Of acute criticism scientific men are rarely tolerant; yet this address, even if it contains debatable matter, shows delightfully how little right they have to throw stones at indifferent or ignorant outsiders. The width of thought, the balance and wisdom shown in this lecture are very remarkable.

It is impossible in a short article to deal with the wide range of discussion contained in other essays; we must content ourselves with enumerating some further titles. "Independence of Science and Research," "Science and Education," "Science and Art," "Social Aspects of Science," "Science and the State," "Organisation of Scientific Research," "Polish Physiography," "Science and Economic Life," "Polish and International Science"—such are the subjects treated by various writers in an interesting or inspiring manner.

The fourth volume of "Nauka Polska" contains much that is valuable and interesting both in matter and scope. Reference may be made to a collection (pp. 81-286) of essays discussing the prospects and possibilities of scientific research in small towns or in the country, far away from libraries, laboratories, and the inspiring influence of university surroundings. Eighteen authors present us with a survey of scientific work that can be accomplished in remote parts of a large country such as Poland. Particularly valuable is Prof. Banachiewicz's contribution on "Amateur Astronomy," an article remarkable for the ability with which a variety of sound information has been epitomised, technical language, as far as possible, being avoided. In a very interesting essay Prof. Birkenmajer gives a list of gifts and benefactions to the Jagellonian University of Cracow in the fifteenth and sixteenth century, beginning with the gift by Queen Jadwiga of Poland, in 1399, of her jewels and other precious objects for the re-erection and endowment of the Jagellonian University, founded by her grandfather in 1364. This noble example was followed by many later benefactors. Another noteworthy feature of the volume is a short but very suggestive essay by Prof. Rozwadowski on "Science, Art, and Religious Belief." We notice also the following contributions: "National and International Science," by Prof. Gawroński; "Longevity of Chemists" (and particularly of Polish chemists), by Prof. J. Zawidzki; "Organisation of Science in France and the United States of N. America," by Messrs. Drzewiecki and Znaniecki.

In conclusion we can only say that we have laid down these volumes with a feeling of real sympathy and warm appreciation.

[1] "Nauka polska, jej potrzeby, organizacja i rozwój," vol. iii. pp. viii+280, vol. iv. pp. ix+590. (Warsaw: The Mianowski Institution, 1920 and 1923.)

Formation of Organic Compounds from Inorganic by the Influence of Light.

DR. O. BAUDISCH contributes to *Science* of April 20 a very interesting account of work carried out by him on the photo-chemical production of organic nitrogen compounds and the influence of iron on nitrate reduction.

The purely chemical investigations originated from bacteriological experiments in which the author found that, in the case of cholera bacilli, the reduction of nitrates stands in direct relation to the oxygen respiration of the bacteria and also to their iron content. A somewhat analogous catalytic effect was discovered in investigating the reduction of nitrites by means of glucose in carbonate solution. Although no reaction takes place, even on heating under pressure, in the absence of iron, the smallest trace of an iron salt is sufficient to bring about the reduction of a large amount of nitrite. Under these conditions nitrates remain entirely unattacked, but are instantaneously reduced to nitrites even in the cold in the presence of oxygen and ferrous salts, an observation of considerable importance in connexion with biological reduction processes.

In contact with moist air, ferrous bicarbonate rapidly absorbs oxygen, yielding a labile peroxide compound, a reaction which the author compares to the fertilisation of an ovum. This is capable of forming a co-ordinated complex with the potassium nitrate, which then splits off an oxygen atom. Reduction of the nitrite is then assumed to proceed further to the extremely reactive potassium nitrosyl, K(NO), which at the same time reacts with organic substances present, especially aldehydes, to form carbon and nitrogen containing compounds. In this reaction ferrous bicarbonate and oxygen assume the rôle of light.

Ferrous bicarbonate peroxide is also capable of giving up the loosely linked oxygen molecule to oxidisable compounds, just as hæmoglobin absorbs oxygen and gives it back again for oxidation or dehydrogenation processes. The reaction is selective and depends upon the affinity of the compound to be oxidised, to form co-ordination compounds with the iron.

A comparison is drawn between the processes outlined above and the reducing action of soil bacteria, and it is concluded that the chemical reactions are, in both cases, very similar. The bacteria which do not need light most probably use the energy of the iron peroxide in rendering nitrates available for protein formation.

University and Educational Intelligence.

CAMBRIDGE.—Mr. T. Basil Buxton has been appointed as the first occupant of the newly created chair of animal pathology.

LEEDS.—The University has appointed Mr. J. A. S. Ritson to be professor of mining in the University, in succession to Prof. Granville Poole, who has been elected to a professorship at Armstrong College, Newcastle-on-Tyne. Mr. Ritson was educated at Uppingham and at Durham University (Armstrong College), where he graduated with distinction in mining and surveying, and has had considerable practical experience of colliery management in various parts of the country. He acted for some time as personal assistant to Sir William Walker, late Chief Inspector of Mines, and is at present senior inspector of mines in the Cardiff district.

ACCORDING to *Science*, the degree of doctor *honoris causa* of the University of Strasbourg has been conferred upon Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research.

THE honorary degree of doctor of science of the University of Wisconsin has been conferred, according to *Science*, upon Prof. The. Svedberg, of the University of Uppsala, in recognition of his work on colloid chemistry and as director during the past term of the research work of the University.

A PROSPECTUS of the Faculty of Engineering of the University of Bristol, which is provided and maintained by the Society of Merchant Venturers in the Merchant Venturers' Technical College, Bristol, has just reached us. Courses of study are available at the College for persons intending to engage in civil, mechanical, electrical, or automobile engineering, and particulars of these courses are given in the prospectus. The ordinances and regulations relating to degrees and diplomas in engineering subjects are included, and some particulars of the Bristol Sandwich system of training engineers are also given. The prospectus can be obtained from the Registrar of the Merchant Venturers' Technical College, Bristol.

THE May issue of the *Phoenix*, the magazine of the Imperial College of Science and Technology, contains a brief account of two comparatively recent diploma courses inaugurated at the Royal School of Mines, dealing with the technology of oil and mining geology. The former course was started in 1913 in order to provide the petroleum industry with men thoroughly trained in certain branches, especially oil-geologists and chemists. The principles of drilling and allied oilfield-engineering are dealt with exhaustively, but the practical work is wisely left to the post-graduate stage of a student's training, when, engaged on work in an actual oilfield, he acquires that experience under far better conditions and in much shorter time than would be possible with an experimental rig designed for intermittent academic instruction, even if this were available. The application of geology to metalliferous mining is another advance made within recent years, and qualified mining geologists, as distinct from mining engineers, have not been long available in Great Britain. This state of affairs was remedied by the introduction of a mining geology course, which, like the older established course in mining, requires four years for its completion; arrangements are also made whereby an associate in either subject may, on working for a fifth year, acquire the double associateship in both mining and mining geology, the combined knowledge of these two subjects, and the wider training and qualification obtained, constituting attainments in every way essential to those whose ambition it is to rise high in their future profession. In both the technology of oil and mining geology courses, the importance of outdoor field-work is insisted on, and a great deal of the student's time is taken up with geological and topographical surveying.

STATISTICS of Public High Schools in the United States (Bulletin, 1922, No. 37) show that the school population has been doubling itself fairly regularly every ten years since 1890, the actual figures for that year and the end of each subsequent decade being: 202,963; 519,251; 915,061; 1,857,155. This rate of increase is about the same as that shown by statistics of secondary-school pupils in England and Wales during the past ten years; but whereas in the United States the pupils in the public high schools in 1920 were 1·76 per cent. of the total population, in England and Wales the percentage in secondary schools was only about half that figure. Of all secondary pupils, those in public high schools in 1920 formed 91 per cent. (in 1890, 1900, and 1910—68, 82, and 89 per cent. respectively), those in Roman Catholic high schools and academies 4 per cent., and those in other private institutions 5 per cent. The number of pupils to a teacher in the public high schools, after rising from 22·3 in 1890 to 25·5 in 1900, fell to 22 in 1910 and 20·5 in 1920. In private institutions the number fell from 13·2 in 1890 to 10·9 in 1900 and 10·5 in 1910, and rose to 12·3 in 1920. The tendency towards concentration of pupils in large schools is reflected in a sharp rise in the number of pupils per school from 89·6 to 139·5 in the public schools and from 65·9 to 88 in the private schools between 1910 and 1920.

THE rôle of the text-book in the public schools of America is subjected to some candid criticism in the annual report for 1922 of the president of the Carnegie Foundation for the Advancement of Teaching. Where text-books are prescribed by the State legislature the publishers' contracts run into millions of dollars, and editions vie in size with the season's "best-seller" novels. The criticisms are directed not so much at the dangers of collusion between publishers and legislators, which have been greatly diminished, as at the influence on school curricula of the large profits incidental to such large editions. To a teacher the production of a new text-book which shall obtain the approval of the State education department is the only road whereby his professional knowledge, experience, and talents may lead to affluence, and a vast amount of industry and ability has been devoted to this work. Many of the books produced are excellent, but their very excellence has accentuated two unfortunate tendencies: towards the multiplication of courses and of studies, and excessive separatism in teaching. "A reform of the school curriculum, planned to return once more to a conception of the school along simpler and more sincere lines, would find itself confronted with the fact that the means of instruction provided by the text-book publishers and the text-book writers and accepted by the authorities are . . . small doses administered at fixed times from stated text-books." This pigeon-holing system, under which the pupil's separate unrelated studies neither interest him nor give him a perspective, is of course not peculiar to the United States, nor are there wanting systematic attempts to displace it there. It is by way of revolt against it that the "project" method is now being encouraged in America, especially in elementary schools.

Societies and Academies.

SYDNEY.

Royal Society of New South Wales, June 6.—Mr. R. H. Cambage, president, in the chair.—A. L. **Kroeber**: Relationship of the Australian languages. Native terms for a number of fundamental concepts, chiefly names of body parts, were transcribed into a standardised orthography, and the data for each concept were entered on maps. Schmidts' fundamental separation of South and North Australian languages seems unnecessary. The languages are divided into groups, 8 southern and 7 northern; of 11 stems, each appears in a majority both of northern and southern groups, and each of 22 others in at least two southern and two northern groups. Genetic unity of all Australian languages seems probable.—J. **Read** and G. J. **Burrows**: Note on the dilution of ethylenebromohydrin with water. When ethylenebromohydrin is diluted with water a continuous absorption of heat occurs until a dilution of about 80 per cent.; further dilution from about 75 per cent. to 10 per cent. is attended by a continuous evolution of heat. Upon reversing the process an initial positive thermal effect is followed by a negative thermal effect. The volume of the solution is always less than the combined volumes of the two components: at 20° a maximum contraction of 1·07 per cent. occurs at a concentration of 50·041 per cent., corresponding closely with the ratio $1C_2H_5OBr : 7H_2O$. Density and viscosity measurements afford no indication of hydrate formation.—G. **Taylor**: The warped littoral around Sydney. Pt. I. The region within one hundred miles of Sydney is dominated by warps to the north, west, and south. Of these the well-known Blue Mountain monocline is the largest. The area is subdivided into 15 geographic regions symmetrically arranged about an east-west axis through Botany Bay. The central portion forms a "stillstand," bounded to the west by three silt-lakes along the Nepean. The coastal features are also symmetrically arranged. Port Hacking is a geographic parallel to Port Jackson, as Illawarra is to the Tuggerah coast. Sydney is unique in that a city of a million people is surrounded on almost all sides (at 50 miles distance) by a belt of country with scarcely an inhabitant. This is a result of geographic controls.—A. R. **Penfold** and R. **Grant**: The germicidal values of the principal commercial eucalyptus oils and their pure active constituents, with observations on the value of concentrated disinfectants. From commercial eucalyptus oils, and also the waste products obtained therefrom after rectification, cheap disinfectants having a high germicidal value can be manufactured. The crude oils gave coefficients varying from 5 to 12, while the pure constituents varied from 3·5 up to 22·5. The germicidal activities of the crude oils is due to certain aldehydes, alcohols, and phenols.—M. **Henry** and W. L. **Hindmarsh**: *Stypandra glauca* (a suspected poison plant). Experiments on thirty-two animals of five species, carried out in five different months and over a space of three years, were entirely negative. Sheep fed solely on *Stypandra glauca* for twenty-five days remained perfectly healthy.

CAPE TOWN.

Royal Society of South Africa, June 20.—Dr. A. Ogg, president, in the chair.—Sir Thomas **Muir**: Note on the successive differentiation of a product of linear functions.—J. Steph. v. d. **Lingen**: The differential bactericidal effect of the visible spectrum. The author discussed the results of Bie, Marshall Ward, Downing, and Russ, and also those obtained by Bayne-Jones and himself. In the work of these investigators the technique was to expose a culture for a given time and then to incubate it for 24 hours or more. On the results of the incubation conclusions were drawn with regard to the bactericidal effect of the various regions of the spectrum. The author described a new method for studying the bactericidal effect. Filters were placed in front of a series of small boxes (chalk boxes) each of which contained four nutrient agar slopes. After inoculating the slopes with bacteria they were placed in the boxes, which fitted into an incubator. In front of the incubator rows of tungsten lamps were placed so that the distribution of light was uniform on the cultures. By adjusting the intensity of the light to a suitable value, the inhibitory and bactericidal effects of the various regions of the spectrum could be studied, as well as the effects of total illumination and total darkness.—J. P. **Dalton**: On the attraction-coefficient for substances of low critical temperature. Some years ago the author found the dependence of van der Waal's a upon temperature for isopentane using Young's saturation data, but at the time sufficient saturation data were not available for testing the law of dependence for other substances. Since then the brilliant researches of Kamerlingh Onnes and his collaborators at Leyden have made available accurate saturation data for other substances of low critical temperature, and their results have been used to determine the constants of the above relation for argon, oxygen, nitrogen, and hydrogen. For these four substances a can well be represented as an exponential function of the temperature, and the agreement between the values of a calculated from the experimental data and those yielded by an equation of the type $\log a = \alpha - \beta T$ is very good.—C. W. **Mally**: X-rays as a means of detecting imperfections in fruit. An effort to find an infallible means of detecting internal defects in export fruit led to a trial with X-rays. Radiographs reveal the internal structure in detail. The ensemble of sound fruit is harmonious, whereas defects cause conflicting shadows to appear in the radiograph. The presence of fungal or bacterial organisms which produce decay is indicated in the radiographs by structural details being more or less obscure. This makes it possible in pathological research to determine with a great deal of certainty whether or not any given fruit that is to serve as a culture medium is sound and also to record the progress of the organisms by means of radiographs at regular intervals. The practical application to fruit inspection depends on satisfactory visibility on the fluoroscopic screen being attainable.

Official Publications Received.

Leeds University: Department of Pathology and Bacteriology. Annual Report by Prof. Matthew J. Stewart and Prof. J. W. McLeod. Pp. 11. (Leeds.)

Board of Scientific Advice for India. Annual Report for the Year 1921-22. Pp. vi+79. (Calcutta: Government Printing Office.) 1 rupee.

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 7: Educational Work of the Young Men's Christian Association. By William F. Hirsch. Pp. 25. 5 cents. Bulletin, 1923, No. 9: Supervision of One-Teacher Schools. By Maud C. Newbury. Pp. iii+55. 10 cents. Bulletin, 1923, No. 23: The Social Studies in Civic Education. By Edgar Dawson. Pp. 16. 5 cents. (Washington: Government Printing Office.)

1-szy Zjazd Chemików Polskich w Warszawie, 3-6 kwietnia roku 1923. Pp. xxiv+64. (Warszawa.)

Roczniki Chemji: organ Polskiego Towarzystwa Chemicznego. Poc redakcja Prof. Jana Zawidzkiego. Rocznik 1921. Tom 1, Zeszyt 1-3. Pp. 177. Tom 1, Zeszyt 4-6. Pp. 178-337. Tom 1, Zeszyt 7-9. Pp. 338-487. Rocznik 1922. Tom 2, Zeszyt 1-3. Pp. 106. Tom 2, Zeszyt 4-6. Pp. 107-336. (Warszawa.)

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The Adaptational Machinery concerned in the Evolution of Man's Body.[1]

By Prof. Sir ARTHUR KEITH, F.R.S.

INTRODUCTORY.

TELEOLOGY, a word so familiar to readers of the works of Archdeacon Paley and of Sir Charles Bell, has disappeared from the vocabulary of scientific men. Darwin killed it; he put an end to natural theology and to Bridgewater treatises. Yet all those wonderful contrivances which Paley culled from the animal kingdom remain true; they are facts which have to be explained. The human hand is, as Bell maintained, a most effectively designed structure;[2] a modern evolutionist can still study with profit the account he gave of the mechanical contrivances to be seen in every part of the human body.[3] Modern discovery has served but to heighten our sense of wonder at the ingenuity which Nature has lavished on the human body. The means she has installed for fighting infection and internal disorders are almost beyond belief. In complexity and in efficiency of design the human brain far excels any invention or organisation the most fertile imagination of man has yet conceived. Engineers, in designing all their contrivances, ensure stability during emergencies by allowing a "factor of safety"; in all systems of the human body the "factor of safety" is more than ample. In this respect the human body has been made almost "fool-proof."

If, then, teleology has disappeared from our evolutionary vocabulary, its substance remains; we have still to find a rational explanation for the manifest contrivances of the human body; a "doctrine of adaptation to purpose" is still a necessity. The followers of Paley had an easy task; they had but to wave a theological wand, and the origin of all of Nature's contrivances was instantly explained. But we followers of Charles Darwin have a much more laborious undertaking in front of us; we have to discover and demonstrate in the body of man, in the developing embryo, and in the growing child the actual machinery which has wrought its marvellous and purposive organisation. In this lecture, given in memory of Huxley at his old hospital and school, I propose to see how far modern discovery has revealed the nature of the adaptational machinery of man's body.

[1] The 12th Huxley Memorial Lecture, delivered at Charing Cross Hospital Medical School on June 27.

[2] The Hand, its Mechanism and Vital Endowments as evincing Design. London, 1833.

[3] Illustrations of Paley's "Natural Theology." An Appendix to Lord Brougham's edition.

HUXLEY AS HUMAN ANATOMIST.

Of all the men who stood round Darwin as helpful critics, Huxley has come out best; time has upheld his judgments and shown that when he doubted he had the intuition of genius. His opinions concerning the evolution and adaptations of the human body are of particular value, for, at two periods of his career, he was a close student of human anatomy. The first of these was spent in this school, from 1842 to 1846, when he passed from his seventeenth to his twenty-first year, and qualified for the practice of medicine. Then, after sailing the high seas of zoology for a dozen of years, he again made the human body one of his main themes of interest, and it remained so for a period of fully twelve years—from 1858 to 1871—when he again returned to the larger problems of zoology and evolution. No doubt his return to the study of man's body in 1858 was to correct certain doctrines which Owen was promulgating concerning it, and to support Darwin's "Origin of Species," which was issued at the close of 1859.

HUXLEY ON TELEOLOGY.

How, then, did Huxley explain the origin of those excellent contrivances in the human body which had commanded the admiration of so many generations of anatomists? It was not until 1876, when he was in the fifty-first year of his age and at the zenith of his intellectual power, that he gives us a glimpse within his mind and permits us to see how he viewed teleology—the science of adaptation. In the early spring of 1876 he gave a lecture in Glasgow, selecting "the hand" as his subject—the text which had served Sir Charles Bell for a Bridgewater treatise. How had man come by his hand? By what evolutionary means had the clumsy climbing anthropoid hand become the dexterous grasping hand of man? If Huxley had believed, as Lamarck, Spencer, and Darwin did, that "functionally wrought" modifications could become hereditary—that a simian stock, were it to use its arms and hands as man now uses his, would in the course of

many generations come to have human hands and arms—then the evolution of the human hand was a comparatively easy problem. At no time of his life did Huxley believe that the effects of use or disuse did become hereditary. In 1890 he wrote:[4] "I absolutely disbelieve in use-inheritance as the evidence now stands."

Having thus rejected the only known means by which useful or purposive modifications of the body can be brought about, we turn with some degree of curiosity to his lecture in Glasgow[5] on the evolution of the hand. The exact title which he gave to his discourse was "On the Teleology and Morphology of the Hand." This is how he approached the problem of adaptation:

"To be a teleologist and yet accept evolution, it is only necessary *to suppose that the original plan was sketched out—that the purpose was foreshadowed in the molecular arrangements out of which the animals have come.*" Then twelve years later (in a letter to Romanes in 1888) he wrote[6]: "It is quite conceivable that every species tends to produce varieties of a limited number and kind, and that the effect of natural selection is to favour the development of some of these, while it opposes the development of others, *along their predetermined line of modification.*"

Huxley as an Evolutionary Predestinarian.

Thus it will be seen that Huxley, on the evidence then at his disposal, had come to the startling conclusion that the shaping or controlling forces which, in due season, were to give man his hand, lay latent in the germ-plasm of that simian stock which ultimately blossomed into human and anthropoid shapes. The evidence which forced Huxley to take up the position of an evolutionary predestinarian must have been indeed cogent. Only a few years previously (1868), Sir Richard Owen had given utterance to a somewhat similar belief, when he wrote:[7] "Generations do not vary accidentally in any and every direction, but in preordained definite and correlated courses." Huxley, as was afterwards the case with Weissmann, believed that the creative machinery of evolution lay in the womb of the germ-plasm.

Modern Predeterminists.

Manifestly, if the evolutionary fate of man is already determined by the properties of his germ-plasm, as Huxley believed, it is a truth of the utmost consequence to medical men. We cannot, if this be true, in any way control the future of humanity, except by the application of Darwin's law of selection. Man's destiny lies hid in the potentialities of his germ-plasm. Huxley's belief is widely shared by modern students of evolution. No one has had better opportunities of noting how evolution has worked in shaping higher mammals during the Tertiary period than Dr. H. Fairfield Osborn, of the American Museum of Natural History. He finds ample evidence of a "definite or determinate origin of certain new characters, which appear to be *partly* a matter of hereditary disposition."[8] He finds that evolutionary tendencies, like that which leads to the formation of horns and antlers, may lie latent in an ancestral stock, and only become manifest at subsequent times and in different ways in certain of the descendants of that stock. That evolutionary manifestations of this kind have taken place in the evolutionary history of the higher primates—the group to which man belongs—there can be no doubt.

In recent times this conception of evolution working out its effects in predetermined directions has been forcibly suggested by Bateson. In his presidential address to the British Association in Australia in 1914 he expressed himself thus:

"If then we have to dispense, as seems likely, with any addition from without, we must begin seriously to consider whether the course of evolution can at all reasonably be represented as an unpacking of an original complex which contained within itself the whole range of diversity which living things present. . . . At first sight it may seem rank absurdity to suppose that the primordial form or forms of protoplasm could have contained complexity enough to produce the diverse types of life."

In this passage Bateson plainly suggests that the machinery of evolution has proceeded on its way, untrammelled by any outward circumstance, right from the first appearance of living protoplasm. We have here the doctrine of evolutionary predestination stated in its most extreme form. Whether such a belief as this of Bateson is well founded or not, it shows us that one who has given a lifetime to the study of variation and of heredity is of opinion that the evolutionary machinery which has given man his brain, his hand, his foot, and his posture has worked out its effects undisturbed by the surrounding conditions of life. In brief, functionally wrought modifications have had no part in shaping the human body.[9]

Before proceeding to set out the evidence concerning the nature of the machinery which shapes man's body, there is another opinion, akin to that of Huxley, which

[4] Life and Letters, by his son, Leonard Huxley, 1900, vol. 2, p. 268.

[5] Life and Letters, vol. 1, p. 456. I have been unable to obtain any published account of this lecture save that given by Mr. Leonard Huxley in the "Life and Letters."

[6] Life and Letters, vol. 2, p. 188.

[7] Anatomy of Vertebrates, vol. 3, p. 808.

[8] The Origin and Evolution of Life, 1918, p. 278. In this work the reader will find references to literature bearing on predeterminism in evolution.

[9] It is unnecessary to give here a list of the men who have concluded that plants and animals tend to vary in definite directions, whatever be the circumstances in which they are placed. The evidence relating to this matter has been very ably summarised in recent times by E. S. Russell, Form and Function, London, 1916; and by Prof. R. Anthony, "Le Determinisme et l'Adaptation Morphologique," *Archives de Morphologie*, Paris, 1922.

deserves to be considered here. It was given by Prof. G. Elliot Smith,[10] and is founded on a prolonged and intimate study of the brain of man and of the brains of animals which have a close structural relationship to man:

"And if all the factors in his (man's) emergence are not yet known, there is one unquestionable, tangible factor that we can seize hold of and examine—the steady and uniform development of the brain along a well-defined course throughout the Primates right up to man, which must give us the fundamental reason for man's emergence and ascent. . . . Thus at the dawn of the Tertiary period there were developed the germs of all the psychical greatness which, in the million or so of years that have followed, culminated in the human mind."

Without a doubt the brain of the great anthropoids is but an elaborated edition of that which serves the needs of monkeys, and, in turn, the brain of man, while framed on exactly the same plan as that of the great anthropoid, far transcends it in complexity of elaboration. In the evolution of these three stages, represented by the brains of man, anthropoid, and monkey, we are witnessing, not an unpacking, but an ever-increasing degree of specialisation as von Baer and Spencer recognised long ago. In the organisation of the brain of the monkey we see something which is comparable to the civilisation of a primitive people, such as the aborigines of Australia; in that of the anthropoids, one which may be compared with the life led by a semi-civilised people, such as the natives of the Congo, while in the human brain we reach a stage of complexity represented by the highest modern civilisation. Whether we speak of brains or of civilisation, the machinery of evolution must be of an analogous nature in both of them. What is the nature of this machinery?

How Adaptations appear during the Development of the Embryo.

Since the time of Darwin and of Huxley our knowledge of the factors which take a part in controlling the development, and therefore the evolution, of the brain and of its appended sense organs, such as the eye, the ear, and the nose, has entered a new phase. We shall take the formation of the eye as our first example because in design and execution it far excels any camera yet invented; it has been the theme of many a teleological sermon, and a consideration of its development will take us right to the heart of our subject—the origin of purposive or adapted structures. After the publication of the "Origin of Species," Mr. J. J. Murphy, of Belfast, cited the eye as a structure which could not be accounted for by any theory of selection then propounded. "It is probably no exaggeration to suppose," wrote Mr. Murphy,

that in order to improve such an organ as the eye at all, it must be improved in ten different ways at once, and the improbability of any complex organ being produced and brought to perfection in any such way is an improbability of the same kind and degree as that of producing a poem or a mathematical demonstration by throwing letters at random on a table.[11]

Darwin, with that customary candour which regulated his search for truth, quotes in full this cogent and, to my way of thinking, just criticism, and Darwin's reply was that the eyes of men, as of animals, did show slight degrees of individual variation, and that he could conceive the twilight eye of the owl or of the lemur as having arisen by a selection and accumulation of these minute variations. Mr. Murphy modestly estimated the parts of the eye which must undergo a simultaneous modification, if sight was to remain efficient, as ten in number; he would have been inside the mark if he had said ten thousand. We cannot conceive how the countless elements which go to the construction of an eye can assume their appropriate place, form, and function unless we postulate a machinery which regulates the development and growth of every one of them.

The existence of such a machinery was made evident by experiments on tadpoles carried out by Dr. Warren H. Lewis at Baltimore from 1903 onwards.[12] The optic cup, which ultimately forms the retina of the eye, grows out from the wall of the brain towards the embryonic skin or ectoderm. When this cup comes into contact with the ectoderm, the overlying cells begin to proliferate and arrange themselves so as to form a transparent or crystalline lens. Dr. Lewis transplanted the outgrowing optic cups of tadpoles, and found, if they were placed under the ectoderm of the neck or of the belly, that the result was the same; an optic cup caused the overlying cutaneous cells to alter their nature and form a lens. Dr. Lewis realised the significance of his discovery; in the developing embryo, although only of certain species, one group of living cells can enslave and control the behaviour of another group. He gave us a glimpse of the kind of evolutionary machinery employed in fashioning a highly purposive structure such as the eye. Any one who has followed the success with which physicists have unravelled the structure of the atom in recent years will not despair of an equal success attending the efforts of embryologists to uncover the means by which one

[10] British Association Reports, 1912 (Dundee), pp. 575-598.

[11] The Variation of Animals and Plants under Domestication, 1868, vol. 2, p. 222.

[12] "Experiments on the Origin and Differentiation of the Optic Vesicle of Amphibia," *Amer. Jour of Anat.*, 1904, vol. 3, pp. 507, 805; 1907, vol. 7, pp. 144, 259. See also Spemann, *Zoolog. Jahrbuch*, 1912, vol. 32, p. 1.

group of embryonic cells regulates the growth of a neighbouring group.

Our knowledge of the machinery by which the growth of embryonic tissues is controlled and shaped is likely to increase rapidly, for in recent years embryologists have copied the methods invented for the study of bacteria, and have succeeded in growing the live tissues of embryos in artificial media. It has been proved time after time that the epithelial cells of an embryo, such as the living cells of renal tubules, if grown apart from other cells, spread outwards in a more or less disorderly manner; but if connective-tissue cells are added to the culture, then the epithelial cells form orderly ranks, just as they do in the kidney tubules of the embryo.[13] Carrel[14] found that the juices of embryonic tissues contain substances which cause cultures of living cells of any kind to proliferate rapidly and to continue alive for an endless series of generations. Thus it will be seen that the machinery which regulates the behaviour of groups of cells within the body of the embryo is one of the utmost complexity, and yet is of a kind which can be handled and studied by biologists. Nor can we doubt for a moment that the machinery of development and of growth which we find at work in the embryo is also the machinery of adaptation and of evolution. In every phase of the development and evolution of the human hand we see this adaptational machinery at work.

Behaviour of Young Nerve Cells.

There is no need to tell even the uninitiated that the brain and nervous system of man comprises many thousands of millions of microscopic units or nerve cells. Each unit of the brain has its appropriate place in a tremendously complex system, and has its special duty in dealing with the tide of messages which flood that system in every hour of conscious and subconscious life. When a child is born all the nerve centres which regulate the complex apparatus of breathing start into instant and effective operation. When the mother's teat is placed within its lips the nerve centres which regulate this intricate series of actions start to work as if they had served an apprenticeship before they appeared in the orderly development of the babe's nervous system. We cannot yet explain satisfactorily the means by which such really marvellous evolutionary results have been reached, such as reflex nerve centres, ready for action at the moment of birth, but at least we can claim to have before us a prospect of giving a rational account of how the various groups of nerve units are assembled so as to give a functional result.

Our present knowledge of this matter is largely due to the researches of Dr. Ariens Kappers[15] of Amsterdam, and to investigations made by his pupils. Nerve cells may not remain in the sites at which they are developed; in their younger stages they have the power to migrate. Dr. Kappers found that a group of embryonic nerve cells or neuroblasts, which are afterwards to control definite sets of muscles and therefore to be concerned in carrying out certain actions of the body, migrate towards the sources of their information. Those young executive nerve cells take up their permanent stations at points most suitable for the performance of their life's work. If we conceive a mob of war-seasoned men to deploy automatically and to take up effective battle-stations we have before us a picture of what is to be seen taking place among the nerve cells in the brain of the growing human embryo. Developing nerve cells send out processes which effect unerring contacts with other distant cell-groups of the body. Dr. Davidson Black[16] found that certain cell-groups on the cortex of the brain proceeded in their development only if the processes of another distant group of cells had entered into contact with them. We have here another instance of one embryological group of cells determining or controlling the development of another group. Enough has been said to show that the machinery which regulates the development and growth of the brain is one of the utmost complexity. We have no reason to suppose that it is of a kind which lies beyond the comprehension of the human mind, although it may take centuries of neurological inquiry to lay bare its nature. The one point we are certain of is that the factors which regulate the development, growth, and arrangement of the countless units of our nervous system do work in such a way as to produce an effective functional result.

The Evolution of Muscular Adaptations.

In no system of the human body do we find more instructive examples of mechanical adaptation than in the muscles which carry out the movements of our bodies and of our limbs. The nature of the machinery involved in the elaboration of muscular adaptations may be illustrated by the development of muscles which guard the mouth, eye, nose, and ear, and are concerned in expression. The bud which gives rise to the muscles on one half of the face begins at one localised site of the human embryo, a site in the embryonic neck, marked by the hyoid arch. From this site the young muscle cells or myoblasts migrate outwards, over the neck and scalp, round the ear, eye, nose, and mouth; as they reach their destinations they fall into ranks and take up such positions as permit

[13] Ebeling and Fischer, *Journ. Experim. Med.*, 1922, vol. 34, p. 317.
[14] See A. H. Drew, *British Journ. Experim. Path.*, 1922, vol. 3, p. 20.

[15] "Further Contributions to Neurobiotaxis," *Psychiat. en Neurolog. Bladen*, 1916, Nos. 5, 6.
[16] *Journ. of Comp. Neur.*, 1913, vol. 23, p. 351.

them, when fully differentiated, to perform effectively their respective functions. The influences which control their movements and regulate their dispositions we do not know as yet. But whatever the nature of these regulating forces may prove to be, we can see that they are exactly of the same kind as those which control the differentiation of facial musculature in monkeys and anthropoids. The degree of differentiation of the facial musculature of man is but the final stage of a continuous series of evolutionary forms to be traced in the faces of monkeys and anthropoids. The elaboration of the facial musculature runs more or less parallel to the elaboration of the brain.

The manner in which muscular adaptations arise may be better exemplified if we take a muscle which is concerned in purely mechanical actions, such as the latissimus dorsi. This muscle is concerned in pulling the upper arm backwards as in rowing. It works in the human body from a wide firm base, placed in the lower part of the back—one which extends from the sixth dorsal spine to the crest of the ilium. As points of origin it also utilises the lowest three or four ribs, and occasionally also the lower angle of the scapula. This muscle, occupying the lower half of the back, makes its appearance in the human embryo in the lower part of the neck, just below the embryonic shoulder-blade. By the end of the sixth week of development the army of cells which compose the muscle have extended or migrated downwards as far as the fourth rib, reaching the twelfth rib about the seventh week, and the iliac crest by the time the human embryo is two months old.[17] The success with which the developing muscle cells reach their ultimate destinations is one of surprising accuracy; they may take hold of a spine or a rib too far up or too low down, but the total result is always one which makes the whole muscle into an effective mechanical engine. Such variations may make the muscle a little less or a little more useful to the individual. The young muscle cells, when they have reached their definitive sites, arrange themselves in serried ranks, each rank hitched directly or indirectly to the lever through which the collective army of cells exerts its strength.

Now, this muscle has almost the same attachments in the gorilla and chimpanzee as in man; there is a greater range of individual variation in its points of origin; the marksmanship made by the migrating myoblasts is less accurate than in man. In the orang this muscle obtains no direct origin from the ribs, while in the gibbon five or six ribs are seized. In the gibbon, however, there is no direct muscular origin from the crest of the ilium. In the old-world monkeys, and also in their American cousins, the origin of the latissimus is restricted to the lower three or four dorsal spines; the origin from the iliac crest is slight or indirect; while the fibres rising on the side of the thorax are not directly attached to the ribs. Very occasionally one sees fibres rising from the lower angle of the scapula of monkeys, a variation in attachment which has become very common in man. In these variations of attachment we are seeing evolution at work, and its machinery lies in the forces which regulate or control the migratory movements of the young muscle cells.

Influence of Nerve-connections.

It is true that nerve fibres have entered, and formed a union with, the muscle mass in the neck before migration has set in; the nerves are carried along by the migrating muscle horde; differentiation of the muscle fibres begins at the point at which the nerve enters the muscle mass. When muscular fibres are fully differentiated they depend on their union with nerve fibres for a continuance of their health and life. But the migratory impulse, be that impulse what it may, lies not in the nerve union but in the muscle elements themselves, for Ross G. Harrison[18] found, if the limb of a developing tadpole were deprived of its nerve supply, the muscles still became duly differentiated in their usual stations.

Adaptations may appear first as occasional Variations.

Let us take another example to illustrate the manner in which a new muscular feature has been evolved in man's body. The muscles of the calf of man's leg have taken on an enormous growth to raise the heel in walking. The structure of the deeper muscle of man's calf, the soleus, has taken on an extremely complex and efficient arrangement of fibres; its origin from the posterior aspect of the bones of the leg is particularly extensive. In all dog-like or pronograde apes this muscle has a narrow origin from the smaller bone of the leg, the fibula, and this is also usually the case in the orthograde apes, or anthropoids. In man the origin of the muscle has undergone an extension, a large part migrating from the fibula and obtaining an extensive attachment to the tibia. But this extension to the tibia which is constant in man occurs as a frequent variation in all the anthropoids. Out of 8 gorillas examined, 3 had a tibial origin for this muscle; this was also the case in 2 out of 12 chimpanzees, 1 out of 8 orangs, and 2 out of 12 gibbons. In the anthropoids there is a tendency for the soleus to extend its origin to the tibia; in man this tendency

[17] Warren H. Lewis, Keibel and Mall's Manual of Human Embryology, 1910, vol. i. pp. 454-522.

[18] *Anat. Record*, 1908, vol. 2, p. 145; *American Journ. of Anat.*, 1906, vol. 5, p. 121; *Journ. of Experim. Zool.*, 1907, vol. 4, p. 239.

has become a fixed habit. This is but one instance of what is often to be observed in the study of human evolution, where an occasional variation in apes has become the established form in man.

How has this tendency to vary in a definite direction arisen? It is a direction which increases the functional efficiency of the human leg. Has this tendency arisen in apes as a result of the manner in which they climb? Or is it, as Huxley would have us infer, a tendency which is inherent in the developing soleus and has come into existence under the influence of some unknown factor which regulates the developmental movement of muscle cells? I think that Huxley's interpretation is the true one.

Let us take another example. Under the skin of the sole of man's foot lies a muscle known as the short flexor of the toes. In man all its four bellies, designed for the outer four toes, have a solid basis of origin on the bone of the heel; from such an origin the collective muscle can play a helpful part in maintaining the arch of man's foot. Now in the monkey's foot, while the muscle for the second toe arises from the heel, the muscles for the three outer toes retain a primitive origin from an adjacent surface provided by moving tendons. In the gibbon it is usual for the muscle of the third as well as of the second toe to have moved its origin to the heel; in the great anthropoids, particularly in the orang, the muscle of the fourth toe has also left the tendon and migrated to the heel; in man all four have moved. Here we see a human character arising as the culmination of a tendency which can be observed, to a greater or less degree, in the feet of all those animals which are most closely related to man, yet more primitive than him in structure. The migration of origin, on the part of the embryonic muscular cells, is of a useful or purposive kind. We cannot avoid the conclusion that the growth and development of young muscle cells are controlled by influences or means which work towards a functional result.

The Origin of a Muscle peculiar to Man.

Man possesses a muscle which is peculiar to himself—the peroneus tertius—and it will help us to understand how new structural features have been, or are being, evolved if we note the manner in which this muscle makes its appearance during the development of the leg and foot of the human embryo. The peroneus tertius raises the outer border of the foot and assists in applying the sole of the foot to the inequalities of the ground in walking. If we examine a hundred human legs we shall find ninety in which the peroneus tertius is a complete and separate muscle, but in the remaining ten we shall find some in which it is separated only to a greater or less degree from an adjacent and older muscle, the long extensors of the toes, and some in which it is quite unseparated from this muscle, as is the case in the legs and feet of anthropoid apes. In the gorilla one notices occasionally a tendency for the outer fibres of the tendon going to the fifth or small toe to stray or migrate towards the outer border of the foot. When we turn to the developing leg to ascertain how this new muscle makes its appearance in the human embryo, we find, towards the end of the second month of development, that the mass or colony of muscle cells which are to extend the toes, becomes separated from the common extensor mass of the leg, and that, in turn, the muscle cells which are to form the peroneus tertius separate or are cleft from the outer side of the long extensors of the toes—from the part concerned in extending the little toe and incidentally in turning upwards the outer border of the foot. The peroneus tertius represents a colony of muscle cells which have broken away from the parent muscle—the long extensor of the fifth toe. The tendon fibres have broken away from those going to the toe and migrated backwards along the outer border of the foot, thus giving them an advantageous position for the performance of their function in walking.

We have here all the properties manifested by developing muscle masses—a power of cleavage or separation, and a power of migration. What causes these outer muscle cells which are destined to act on the most external of the digits to break from the parent mass and assume a separate functional identity? I agree with Huxley that there are no grounds for believing that the behaviour of embryonic muscle cells is in any way influenced by experiences gained by adult muscle fibres. When vertebrate limbs came first into existence the muscle colonies which deployed to form the extensors of the toes, grouped themselves so as to get a functional result. In the case of the outer toe there was a double function, the extension of the toe and the everting of the foot. In the human foot the muscle cells which evert the foot have separated themselves from those which extend the little toe. The evolutionary machinery lies in the behaviour of the embryonic muscle cells or myoblasts.

Instances of Parallel Inheritance.

Let me cite two other examples which go to show that myoblasts possess evolutionary tendencies which work towards a purposive or functional end. The interosseus muscles of the hand and foot of monkeys arise, not from the adjacent surfaces of metacarpal and metatarsal bones, as they do in man, but from the bases of these bones, in the palm of the hand and sole of the foot. In the human embryo the interosseus muscles appear in the same palmar position as that which is retained in monkeys. In the most primitive of anthropoid apes—the gibbon, and also in the highest of South American monkeys—the howler monkeys—Ateles—the origin of the interosseus muscles have migrated so as to take a partial hold of the adjacent surfaces of the metacarpal and metatarsal bones. In the great anthropoid apes—the gorilla, chimpanzee, orang—and in man, these muscles have sunk in between and seized the adjacent surfaces of the metacarpal bones of the hand and metatarsal bones of the foot. This migratory tendency has seized upon, or become manifested in, the muscles of the hand as well as in those of the foot, although these members are subject to different functional influences. We can account for such evolutionary manifestations only by supposing that in a remote common ancestor of all the members of the higher primates there was a latent tendency in the myoblasts of the interosseus muscles to deploy

and group themselves in a new way, one which gave a better functional result.

Another striking fact is that the muscles which have become reduced or vestigial in man have also become reduced and vestigial, although usually to a less extent, in the anthropoid apes. All of these muscles, plantaris, palmaris longus, psoas parvus, latissimo-condyloideus, omo-cervicalis, etc., are laid down in a normal way during the development of the embryo; after being laid down retrogression sets in. We have here again to deal with functional tendencies. The machinery of reduction is resident in the processes which govern the development of structural systems in the embryo. As W. Roux supposed, there may be a struggle for survival between the system of cells which make up the body of an embryo.

The Adaptational Properties of Bone Cells.

By the fourth month of fœtal life young nerve cells and young muscle cells have taken up their definitive position and arrangement. On the other hand, white blood corpuscles retain all through the life of the individual the migratory power which is lost by most other cells of the body early in fœtal life. The cells which line blood and lymph vessels and those which line the peritoneal and pleural cavities [19] retain all through life a power to proliferate and produce new tissues which are of a purposive kind. Such cells retain the chief characteristic of embryonic cells—the power to arrange themselves as part of a functional complex. Bone cells also retain powers of purposive action. Nothing is better known than that, if a bone of a rickety child bends under the weight of the body, the bone cells lying in its concavity will proliferate and build a buttress to strengthen the shaft. It is not necessary for us to speculate here as to the exact stimuli which cause bone cells to behave in this manner; it is enough for our present purpose to note that they react to fulfil an end necessary for the occasion.[20]

John Hunter discovered the remarkable power which bone cells possess to remodel bones during growth. While bone cells are building at one part of a bone, they are, at another part of the same bone, busily engaged in taking down their previous handiwork. The co-ordinated manœuvres of the armies of bone cells concerned in the growth of the jaws and eruption of the teeth are extraordinary. When teeth are erupting and also long after they are cut, their bony sockets are being constantly altered and remodelled by the hundreds of thousands of osteoblasts embedded in the bone surrounding the dental roots. While new bone is being laid down on the outer side of the jaw under the gum, the corresponding bone on the inner side of the gum is being absorbed. But in the tooth socket itself the opposite is happening; new bone is being laid down on the inner side of the tooth socket, while it is being removed from the wall forming the outer side of the socket. New bone is being laid down under the roots so that the socket as a whole is being raised and moved in an outward direction. The crowd of osteoblasts involved in this operation are clearly co-ordinated in their action; they move on towards a functional result. Although we do not know the exact means by which their action is co-ordinated we have, in the qualities and tendencies, possessed by bone cells, part of the machinery of evolution. Cartilage cells, during embryonic life, must be co-ordinated in their growth and arrangement. In the fœtal hand we find they have fashioned the joints to meet the needs of the muscles which act on them, thus permitting harmonious movements of the wrist and digits. The development and behaviour of embryonic cartilage cells constitute part of the machinery of human evolution.

Co-ordination in the Growth of Bone, Muscle, and Nerve Cells.

I have dealt with the behaviour of young cells of bone, muscle, and nerve centres in the developing embryo in order that we may appreciate the complexity of the process involved in producing a new structural adaptation of the human body. When we sit up or walk, our vertebræ are balanced one upon another by means of a complex series of muscles acting upon an equally complex series of levers, the whole controlled by intricate groups of nerve cells situated in the spinal cord and brain. The anatomical evidence [21] leaves us in no doubt that the spinal mechanism of man has been evolved from one very similar to that now seen in the anthropoid apes. Indeed in the young chimpanzee and gorilla many of man's spinal adaptations are already present. In the evolution of a human from an anthropoid spine we have to conceive, (1) that the multitudes of bone cells involved in the building of vertebral processes of the embryo were so influenced in their operations that the levers they built were altered in strength, inclination, and form; (2) the countless myriads of myoblasts involved in the formation of the spinal musculature were so influenced that they took up new positions and effected new combinations; (3) the cartilage cells, which mould the contours of the intervertebral joints, were moved to alter the shapes of the articular surfaces so as to provide the needed contours; (4) the nerve cells of the spinal cord and brain, presiding over the reflex and voluntary movements of the spinal muscles, had to undergo increase in numbers, rearrangements in grouping, and readjustment of contacts. We have to postulate that in the human embryo there exists a machinery which co-ordinates the development and growth of all the diverse hordes of embryonic cells concerned in the formation of man's spinal mechanism and causes them to move in a direction which, at all stages of evolution, yields a harmonious functional result.

Theory of Hormones.

There is only one theory which affords a rational explanation of how such complex adaptations can be brought about—the theory of Hormones postulated by Starling in 1905.[22] Although Prof. Starling devoted

[19] An account of the actions and reactions of vascular tissues will be found in the writings of W. Roux from 1878 onwards. I have dealt with the adaptative reactions of peritoneal cells in Human Embryology and Morphology, 1921, 4th edition.

[20] I have dealt with the growth reactions of bone cells at some length (Menders of the Maimed, 1919, chapters xiv., xv., xvi., xvii., and xviii.)

[21] "Man's Posture: Its Evolution and Disorders," *Brit. Med. Journ.*, 1923, 1, pp. 451, 493, 545, 587, 642, 669.

[22] Prof. E. H. Starling, "The Chemical Correlation of the Functions of the Body." The Croonian Lectures at the Royal College of Physicians. *Lancet*, 1905, vol. 2, p. 339.

the greater part of his Croonian lectures to demonstrate the part played by chemical substances or hormones in co-ordinating the functions of the body he clearly realised that hormone control formed the basal machinery of all evolutionary processes in the animal kingdom.

"In the lowest organisms, such as the bacteria and protozoa, the only adaptations into which we can gain any clear insight are those to the environment of the organism, and in these cases the mechanism is almost entirely a chemical one. . . . In the lowest metazoa, such as the sponges, there is still no trace of any nervous system. The co-ordination between the different cells of the colony is still determined by purely chemical means. . . . If, as I am inclined to believe, all the organs of the body are regulated in their growth and activity by chemical mechanisms, similar to those I have described, an extended knowledge of hormones gives complete control of the body."

We are justified, on all grounds, in looking upon the human embryo, in the earlier stages of its developing, as a colony of protoplasmic units or cells, organised under a system of government controlled by hormones. Each member of the colony, we must suppose, has the power of circularising, by means of the hormone postal system, some or all of the other members of the colony in such a way as to notify its needs and compel their co-operation. With each step in the differentiation of the embryonic tissues there must be a further elaboration in the hormone system of intercommunication and government, until the fœtal stages are reached, when the growth-regulating substances become installed in special controlling centres represented by the glands of internal secretion—the pituitary, adrenal, thyroid, etc. We know that juices expressed from embryonic tissue contain substances which stimulate the proliferation and growth of living tissues; we know from observations already cited that one group of embryonic cells can control the manner in which another group develops, but we have to admit, also, that our knowledge of the action of hormones in fashioning the growth of organs is still in its infancy. The vista presented by this unexplored field of knowledge is infinite in extent and complexity, and will provide embryologists with many centuries of labour. Their labour will reveal in full the true nature of the machinery which underlies the production of structural adaptations which occur in every part of the animal body in every stage of its evolution.

The Significance of Acromegaly.

A long and close study of the bodies of men and women who have been the subjects of that strange disorder of growth known as acromegaly, has convinced me that the system of hormones, which controls and co-ordinates the growth of various organs and parts of the body is organised, like the nervous system, on a reflex basis. There are reflexes of growth just as there are reflex actions of muscles; both kinds of reflexes serve definite purposes in the economy of the body. The glands of internal secretion provide substances which control the action of organs and of parts of the body; they also produce substances which co-ordinate the growth of the organs or parts concerned in these actions. In the subjects of acromegaly the pituitary gland is enlarged and its structure more or less disorganised; the parts of the body which respond to hard toil, such as the hands, feet, and jaws, become greatly and irregularly overgrown. All the systems of the body—muscular, bony, respiratory, circulatory, alimentary, and renal systems—are involved; all show an abnormal degree and kind of overgrowth.

We find a clue to most of the growth disorders of the human body, such as acromegaly, in a knowledge of the mechanism of normal growth. Growth disorders—dwarfism and giantism—are but derangements of the various parts of the normal machinery of growth. Sir James Mackenzie regards the symptoms of illness, manifested by suffering men and women, as derangements of the normal reflex functions of their bodies. In a like manner we may consider disorders of growth, such as acromegaly, as a derangement of a normal mechanism—that which co-ordinates the response made by the various parts of the body to exercise and training. When a man passes into training, whether it be to use his hands as a labourer, his biceps as a blacksmith, his legs as a runner, or his arms as a rower—the responsive growth is not confined to the muscles of his hand, arm, or leg. All the bones of the body respond to a greater or less degree, so do the heart and lungs, so do all the systems of his body; he has to eat and digest more. We cannot imagine such a co-ordinated functional result being brought about, one which affects every system of the body, unless we postulate a controlling system of hormones. Nor can there be a doubt that acromegaly, in all its stages and degrees, represents a diseased manifestation of this adaptational system.

To fit all the bits of this puzzle into a connected whole we have to suppose that muscles in sustained action do emit certain substances which pass into the circulation and thus reach the pituitary gland. We have to suppose that in the pituitary these substances elicit responses leading to the emission of other substances which pass into the circulation and thus reach and influence organs which are correlated in action with the muscles directly involved. We have here all the elements of a reflex system—the pituitary serving as a chief centre or hormone-brain. In acromegaly the disordered condition of the pituitary leads to a flooding of the body with adaptative hormones after the most trivial of muscular actions, and hence its unregulated growth.

Barwell's Disorder.

In the Museum of Charing Cross Hospital, Huxley's old school, there is the skull of a boy which shows a very instructive disorder of growth. It is not a unique specimen; many cases of an exactly similar kind are known. The boy came into the hospital for treatment of a tumour-like swelling of the face, for which Mr. Barwell tied the right carotid artery. The boy died, and it was found that, on the right side of his skull, all those structures which are concerned in mastication, and only the structures concerned in this function, were greatly and uniformly hypertrophied. The condition was clearly produced long before birth, for all the teeth, including those of the milk dentition, were nearly twice the normal size on the right side of the mouth. So were the jaws and all the bony struts of the face which

support the jaws; so were the muscles of mastication, the temporo-mandibular joint—in short, all dental, bony, muscular, vascular, and nervous structures concerned in mastication. We cannot conceive how such disorders of growth could be so sharply limited to a single functional system unless we agree that the machinery which regulates growth and development is organised not on an anatomical, but on a functional basis.

Use-inheritance.

In the foregoing paragraphs an attempt has been made to picture the means by which the development and growth of the various cell groups, which make up the body of the embryo, are co-ordinated and controlled. Such evidence as we have justifies us in the belief that there is an automatic system of control worked by means of hormones, and that this machinery, in all its variations, tends to produce a functional or adaptational result. The very important question remains to be considered: can this machinery, which controls the differentiation of the tissues of an embryo, be influenced from without? Or does it, as Bateson believes, work on towards its destined result, in spite of all surrounding conditions and influences? The genital glands and their contents, of both man and woman, are exposed to all the substances, be they nutritive or hormonic in nature, which flood their circulatory systems. In 1906 J. J. Cunningham [23] applied the theory of hormones to the problems of heredity. He conceived it possible that the genital cells could be influenced, and so altered in their constitution, by hormones thrown off by all the organs and parts of the parent body. There is no inherent physical obstacle to prevent one from entertaining such a belief. Such a conception implies the possibility of hormones—function-regulating substances—of a parent coming into contact with and influencing the controlling action of the embryonic hormone-system. If it were possible, as is assumed in every form of Lamarckian belief, for parent products to come in contact with, and thus alter, the machinery which controls the growth of the embryo, it would be a consequence of the utmost import for mankind. By a full use of our brains, of our teeth, or of our hands, we might hope to influence the development and growth of the corresponding parts in our children.

Evidence of the Teeth.

I have selected the teeth to test the question as to the part played by use in the evolution of structural adaptations. There can be no doubt that the manner in which the crowns of man's sixteen upper teeth fit against corresponding surfaces of the lower sixteen, give us as fine a structural adaptation as we may hope to cite. There is the additional advantage that, as the teeth are the most persistent of fossil remains, we know more of this system in the forerunners of man and of living anthropoid apes than of any other parts of their anatomy. Further, in highly civilised races teeth are not only more liable to decay and to irregularities of eruption than in primitive races, but there is also, in civilised peoples, a marked tendency to a reduction in size and number of the dental series. We see, too, in the evolution of the dentitions of the higher primates, when the pattern of the enamel changes in one tooth, it changes in all of them; if one tooth alters, the opposing teeth have to alter in conformity; we see that if the dentition strengthens, all the members of the series participate; when reduction sets in, all the teeth suffer a reduction in a definite order. But these changes cannot be due to use, for the crowns of the teeth are laid down, and the opposing chewing surfaces fully formed, while the dental germs lie buried in the gums and long before the crowns come into use. When they do come into use, the teeth formed in the upper jaw possess the exact surfaces needed to oppose those of the lower jaw. After usage, especially in apes and primitive man, the opposing surfaces become worn off; if use had any effect here it would be to produce teeth with eroded crowns.

It is clear that functional adaptation, so far as concerns the production of teeth, is a property resident in the embryonic tissues; the effects of usage in the parent can have no influence on the machinery which shapes the dental crowns in the mouth of the fœtus and infant. If this is true of one system of the human body, it is probably true of all other adaptational systems—such as the brain, hand, and foot. Nature would have been foolhardy to entrust the future of any race whatsoever to the voluntary efforts or natural inclinations of the parents. As far as possible she seems to have safeguarded the progeny by isolating the gonads from the functional influences of the parental body.

The Germ-plasm can be permanently injured.

Yet there is one line of evidence which shows that the spermatozoa of the male and the ova of the female can be acted on or injured from without. Darwin [24] has related the case of a cow in which one eye was injured when she was in calf. The calf was born with the corresponding eye small and blind. In more recent years Marey [25] has recorded an identical result in a mare; one eye was injured when she was pregnant, and the foal was born with the corresponding eye small and blind. Hitherto we have been inclined to regard such cases as mere coincidences, but the well-known experiments of Guyer and Smith [26] provide a rational explanation. They injected into the veins of doe rabbits, about the end of the second week of pregnancy, doses of a substance which has a selective and toxic action on the lens of the eye. Many of the young were born with defects of the eyes—cataract of the lens being particularly frequent. When these young rabbits grew up and bred, many of their young showed the same defects. The developmental disorder could be transmitted in the spermatozoa as well as in the ova. These experiments show that the germ-plasm can be reached from without, and by means of a toxic substance can be permanently injured, so that progeny issuing from it will show ever afterwards a characteristic and localised defect. Prof. Ch. R.

[23] Hormones and Heredity, 1921.

[24] Variations in Plants and Animals under Domestication, 1868, vol. 2, p. 34.

[25] Le Déterminisme et l'adaptation morphologique, R. Anthony, 1922, p. 88.

[26] M. F. Guyer and E. A. Smith, *Journ. Experim. Zoology*, 1921, vol. 31, p. 171.

Stockard[27] induced permanent changes in the germ-plasm of guinea-pigs by exposing one generation of animals to extreme and continuous doses of alcohol. Dr. J. G. Adami[28] cites several instances of a similar nature, and has summed up the evidence relating to "the inheritance of acquired conditions in the higher mammals." Many of the cases recorded to prove acquired inheritance relate to changes which have been produced in the skin, particularly in its pigment-carrying cells. On the evidence which has accumulated there is good reason for believing that light can act upon epidermal and other elements of the skin in such a way as to effect changes in certain factors or elements of the germ-plasm. The observations and experiments made by J. T. Cunningham[29] on the colouring of flat fish, and the more recent observations which Dr. Kammerer[30] has made on salamanders exposed to light, and to dark backgrounds, can be interpreted only if we admit that reactions in the skin can affect the reproductive cells lying within the genital glands of the animals subjected to experiment. Notwithstanding this admission I do not think, as I shall mention later, that the loss of pigment in fair Europeans is due to any direct action of light on the skin. It is one thing to injure or influence the germ-plasm in such a way as to alter the machinery which controls the development of the embryo; it is quite another thing to alter that machinery in such a way as to make it produce a new mechanical adaptation. We know of no means by which the machinery of mechanical adaptation can be altered from without.

Are the Modern Conditions of Life altering the Germ-plasm of the Human Stock.

The admission that the genital cells can be injured or altered by substances circulating in the body of the parent is of the utmost consequence for mankind. The conditions of modern civilisation are making us the subjects of a colossal experiment. Six thousand years ago, our ancestors, scraping a subsistence from moor and shore, passed their days amidst the same conditions as surrounded the earliest types of evolving man. Man's body was adapted for rough fare and unregulated exposure. Modern civilisation has revolutionised the conditions of life in every detail. We use our brains, our skins, our muscles, our lungs, our teeth, stomach, and bowels, our hands and feet, for purposes which are new to them. Our tissues are kept soaked with juices containing substances which are still strange to them. Our crowded communities favour the prevalence and spread of all forms of infectious disorders in young and old. We are discovering that a rough and raw dietary contains certain elements which are essential for health. It would be strange if the evolutionary machinery of the human body kept on working in the same way as when the conditions of life were, if not simpler, yet much more primitive. A prolonged and minute comparison of human remains found in ancient and modern graves in England has convinced me that structural changes of a minor kind are affecting certain parts of the skeleton in at least one-third of modern instances. The narrow bony opening to the nose, with its jib-like nasal spine, its raised and sharp sill, so often seen in modern English skulls, are conditions never present in Englishmen of the pre-Roman periods. Contracted palates, crowded and defective teeth, deformed jaws, sunken cheek-bones do not become common in English graves until we reach the eighteenth century. The appearance of these structural changes in Englishmen cannot be attributed to the introduction of any new racial element from abroad. No doubt these facial changes are due in part to the soft nature of our food, and the disuse of our muscles of mastication.

Lack of use alone will not, however, explain the form taken by these structural alterations; they are injurious rather than helpful; they cannot be classified among the contrived adaptations. We have reason to suspect that defects of eyesight grow more common. There are grounds for believing that the great bowel, including the cæcum and appendix, becomes more liable to disorder and to disease with each succeeding generation. Twenty years ago Metchnikoff[31] expressed the belief that the great bowel of man had become a useless structure, and that he would be better off without it. The result of recent surgical experience has been to convince medical men that the man with a normal great bowel is an infinitely fitter and happier person than the man without one. The only question that remains to be settled is whether it is better to be with or without a colon which has become incurably diseased.

There is thus a certain amount of evidence to support the belief that certain parts of the body are less robust, some of them actually undergoing a structural change, in a considerable proportion of people living under modern conditions of life. There is also no doubt that these changes and susceptibilities occur much more frequently in some families than in others. To what extent these new features have become hereditary and therefore due to an injury of the germ-plasm, we cannot yet say. But in the light of experiments like those of Guyer and Smith, and of Stockard, medical men have grounds for suspecting that the source from which new generations of our race issue may not be invulnerable, that our germ-plasm may become tainted under the conditions to which our bodies are now subjected.

The Law of Recapitulation is only partially true.

In the foregoing paragraphs I have turned aside from my main thesis—the nature of the evolutionary machinery which has given man his gifts of brain and body. The nature of this machinery will never be understood by those who still harbour the belief that the human embryo, in its developmental stages, recapitulates the evolutionary history of the human body. I do not think any one familiar with the stages passed through by the developing human embryo would now agree with Huxley when he wrote: [32]—

[27] "An Experimental Study of Racial Degeneration in Animals treated with Alcohol," *Archiv Int. Med.*, 1912, vol. 10, p. 369; Proc. Soc. Experim. Biol. and Med., N.Y., 1911–12, p. 71; 1913–14, p. 136.
[28] Medical Contributions to the Study of Evolution, 1918, ch. v.
[29] Hormones and Heredity, 1921.
[30] Nature, 1923, vol. 111, p. 637.

[31] The Nature of Man, translated by Dr. P. Chalmers Mitchell, 1904; see also Keith, "The Functional Nature of the Cæcum and Appendix," *Brit. Med. Journ.*, 1913, vol. 2, p. 1599.
[32] Collected Essays, vol. 2, p. 5.

" A man in his development runs for a little while parallel with, though never passing through, the form of the meanest worm, then travels for a space beside the fish, then journeys along with the bird and the reptile for his fellow-travellers ; and only at last, after a brief companionship with the highest of the four-footed and four-handed world, rises into the dignity of pure manhood."

It is true that we cannot explain the infinity of stages passed through by a human embryo, from the fertilised ovum, representing the lowest unicellular stage of living things, to the fully formed child, unless we believe that man, like all animals, has been evolved from the simplest of beginnings. But every one of these transitional stages represents a new form of being, never one of which has been seen at any stage of the world's history leading an independent adult existence. Every organ and part of the human body passes through an extensive series of developmental changes which receive a full and adequate explanation from the theory of evolution, but not one of these changes, from the first to the last, copies a form seen in any adult animal ; at every point of development old or recapitulatory phases are masked by the unceasing introduction of new and individual features. The student of the human embryo and fœtus is impressed not by its recapitulatory behaviour but by the manner in which new features are being intercalated. Such facts favour Huxley's view that the machinery of evolution works in the body of the embryo uninfluenced by adult experience.

The Use made by Nature of the Capitalistic System.

Scientific men do not need to be told that capital is needed for the development and improvement of an invention ; capital is as necessary for the progress of a civilisation as for the extension of a business undertaking. Nature discovered very early in the history of the world that capital is needed for evolutionary progress. A breakfast egg represents the capital set aside for the development of a fowl, and during the incubation period the stock of yolk makes possible any form of experiments which the embryonic cells may tend to make. In the higher mammals the capitalistic system has become fluid and elastic—represented by the mother's blood and milk. The placenta and all accessory structures needed for the lodgment of the young in the mother's womb were invented and elaborated by embryonic cells during the incubating stages in the development of lower vertebrates. The simple yolk capitalistic system, evolved and elaborated by the embryonic cells of lower vertebrates, became, in the higher vertebrates, transformed into the elaborate organisation which gives rise to the placenta, thus securing for the young months of free lodging. When we inquire into the nature of the process which gives rise to the placenta we find that it concerns certain embryonic cells which, in the lower vertebrates, proceed to form part of the belly-wall, part of the bowel, and part of the bladder. These same groups of cells in higher mammals have taken on themselves an entirely new purpose. Instead of proceeding to form the parts of the body just mentioned, they give rise to the placenta and membranes which envelop the embryo. Here we see that embryonic cells and the machinery which regulates their evolutions have inherent in them a power of working out the most intricate inventions and of effecting structural adaptations of the most serviceable kind.

The Genesis of Man's special Structural Features.

We need not be surprised, seeing how plastic and resourceful the embryonic tissues are, to find most—but not all—of man's characteristic features appear in a modified form as transitional phases in the fœtal stages of man's nearest allies—the anthropoid apes. Man's outstanding structural peculiarities have been produced during the embryonic and fœtal stages of his evolutionary history ; the corresponding and somewhat similar characters which appear in fœtal anthropoids become masked in these animals by the superaddition of coarser animal features which develop as their intra-uterine life closes, and particularly as their adolescent and adult stages are passed. At birth the brain of the baby gorilla is almost as big as that of the human baby ; but whereas the period of rapid growth continues in the human brain throughout infancy, the brain of the gorilla proceeds after birth at a slow pace. The human brain retains the rapid rate of fœtal growth for two years after birth. My friend Prof. L. Bolk[33] of Amsterdam, who has done so much to prove that man's distinctive characters represent a heritage accumulated in the fœtal phase of his development, has shown that the downward bend of the front part of the base of the skull, and the consequent backward position of the face, occur at an early point of development in all mammals. The cranial bend becomes undone and the face thrust forwards as development proceeds in all mammals, save in man, in whom these fœtal features are retained until, and throughout, adult life. The nearest approach to the adult human form occurs in the fœtal stages of anthropoid apes. The fœtal cranial bend is not a primitive or ancient character ; it was worked out in fœtal life ; never, until the evolution of man took place, did this feature survive to reach an adult stage.

Let us take another feature—man's hairless skin, and in the case of the white races its comparative lack of pigment.[34] In the chimpanzee fœtus, at the seventh month of development, the hair is distributed on the body exactly as in a baby at birth ; there is the same long and fine hair on the scalp ; the same smooth skin covered with a short, almost invisible down. The skin, too, which afterwards becomes deeply pigmented and black in the adult chimpanzee, at this stage is gray, tinged with a trace of brown. At a still younger stage the skin is almost free from pigment. The young of many of the higher primates are born with fair hair—often tinged with red. Fair hair is a fœtal character of primates which has become permanent in Northern Europeans and is found distributed

[33] "The Problem of Orthognathism," *Proc. Konin. Akad. van Wetensch. te Amsterdam*, 1922, vol. 25, Nos. 7, 8 ; "On the Significance of Supraorbital Ridges in the Primates," *ibid.*, 1922, vol. 25, Nos. 1, 2 ; "On the Character of Morphologcal Modifications in consequence of Affections of the Endocrine Organs," *ibid.*, 1921, vol. 23, No. 9.

[34] See my Herter Lectures, "The Evolution of Human Races in the light of the Hormone Theory," *Johns Hopkins Hospital Bulletin*, 1922, vol. 33, pp. 155, 195 ; also Prof. C. S. Stockard's "Human Types and Growth Reactions," *Amer. Journ. Anat.*, 1923, vol. 31, p. 261.

sporadically in North Africa and Central Asia. Here again we see characters which were worked out in fœtal months passing on to become characters of adult life.

Such examples could be multiplied to a wearisome extent. I do not wish to minimise the number and importance of transient simian features which appear in the body of the human fœtus and infant; they are well known and of great significance. But I do desire to give a true interpretation to such human features as are represented by man's small face and jaws; his forehead, tending to be devoid of supra-orbital ridges; his large head poised on a long and relatively slender neck: they are features first produced in the fœtal stages of higher primates and now retained by man in his adult state. The tendency to preserve such fœtal characters is seen in certain genera of South American monkeys. But all the fossil progenitors of ape and man we have yet discovered have a face, jaws, skull, and neck of the more primitive and bestial type.

The Bearing of Fœtal Inheritance on Huxley's Conception.

I return to Huxley's disbelief in "use-inheritance" and to his conviction that animals—including man—tend to evolve "along their predetermined line of modification." It is clear that the mammalian placenta, particularly that kind of placentation which occurs in the womb of man and of anthropoids—identical systems—cannot in any way be accounted for by "use-inheritance." They have been worked out by properties inherent in embryonic tissues. The fact that the most characteristic features of the human body appear first in embryonic or fœtal life, and that human-like characters appear transiently in fœtal stages of anthropoid apes, the further fact that many constant structural modifications of man's body are seen as occasional variations of the ape's body, all bear out Huxley's dictum that evolution tends to evolve along predetermined lines of modification. The machinery of evolution works out its untrammelled ends in the embryo and the fœtus, except in so far as that machinery can be injured or deflected by what may be termed poisons of the germ-plasm. It is clear, too, that if we are to cast man's horoscope we can read the omens only in the tendencies manifested in his embryonic and fœtal stages. We can alter man's future only in that limited way discovered by Darwin—by applying his principle of selection.

A Simile.

To make my meaning clear, let me borrow a simile from human affairs. Some thirty years ago, in the incipient stages which led to the modern development of the great motor-car industry, small workshops sprang up in almost every town and supplied a car of local design for local needs. The struggle for survival set in, and successful types, ousting local types, led to the formation of great firms which catered for the needs of continents. The workmen engaged and the types of car made became specialised and standardised. These great firms, we know, keep an eye on the market—benefit by experience—and modify their types to suit demand. Invention succeeds invention in their workshops. But in the factory where human types of body and mind are produced I am presuming there is no intelligence department. I am also presuming, as Huxley did, that the workmen—the cells of the embryo—employed in turning out new human machines, are specialised into vocational, hereditary castes—each caste turning out its work in a certain way—a way which ensures a functional result. I am presuming, too, that the workmen represented by the embryonic cells are co-ordinated in their toil by an elaborate system of intercommunication—already described—the system of hormones. All hands in the human factory are co-ordinated—not by orders from managers or foremen, but by a self-regulating system of hormone-control which works out functional ends automatically. Variations—useful adaptations—are produced by a bias which is inherent in the machinery of control. The mere fact that I have to resort to so crude a simile shows how ignorant we still are of the machinery of animal evolution.

Conclusion.

John Hunter gave utterance to an important truth when he said man's bony and vascular tissues retained the same automatic purposive behaviour as is manifested by the lowest forms of organised life, such as the hydra. In the formative period of the human embryo, and on the phase when adaptational contrivances are being worked out in its heart, brain, muscles, and skeleton, the embryonic cells retain many of the purposive, almost conscious, attributes possessed by primitive unicellular organisms. No doubt the behaviour of embryonic cells, as of the simplest protozoa, will prove to be reflex in nature—mere protoplasmic reactions to appropriate stimuli. In bringing about the collective reactions of embryonic tissues, which mould them to form structural adaptations, we may presume that hormones play a leading rôle. The hormone system, to give the results it does, must be framed upon a teleological basis.

If we would rightly understand the evolution of the machinery of adaptation, or, what is the same thing, the machinery of government, in the developing body of an animal, we shall do well, as Herbert Spencer suggested, to study the evolution of a people rising from savagedom to civilisation. In the earlier stages of the evolution of human society we see that the machinery of government is represented by the automatic working of a herd-instinct—an instinct tending in all its operations towards the preservation of the community. The instinct is biassed in the direction of producing functional or effective results. We have to study what, in our present ignorance, we must call the "herd-instincts" of the vast community of protoplasmic units embraced by the body of a human embryo, if we would understand how the structural contrivances of the human body have been evolved. I, for one, believe with Huxley that the government which rules within the body of the embryo proceeds along its way altogether uninfluenced by occurrences or experiences which affect the body or brain of the parent. In short, man has come by his great gifts—his brain, his upright posture, his strange foot and his nimble hand—not by any effort of his own, but, like a favoured child of the present day, has fallen heir to a fortune for which he has never laboured.

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Lord Grey's Bill for the Protection of Wild Birds.

WE have now for many years had legislation in Great Britain for the protection of wild birds, in addition to the much older laws relating only to game. The desirability for such protection has received increasing recognition on humanitarian and æsthetic grounds, and it is also to be hoped that there is a growing realisation of the importance of the subject from an economic point of view. The different Acts which have successively been placed on the Statute Book have had varying merit as judged by the wisdom of their intentions, but where they have all so lamentably failed is in their ineffectiveness. This grave fault has been remedied in the wise measure which Viscount Grey of Fallodon has introduced into the House of Lords, and, although his Bill has many other good points, it is probably on that ground that we should chiefly welcome it. The Bill was read a third time on July 30, and a copy of it, as amended in committee, is before us. It is greatly to be hoped that the House of Commons will similarly pass the measure next session.

The Bill aims at the repeal of all existing enactments on the subject, and at making complete provision on the new lines recommended in 1919 by the Departmental Committee on the Protection of Wild Birds. All birds to which the Bill applies—that is to say, all wild birds other than grouse, ptarmigan, partridges, pheasants, and black game—are divided into three categories, each of which is to receive its appropriate degree of protection, as follows:

> Category I.—Birds in this group, and their nests and eggs, are to be protected absolutely at all times and places.
>
> Category II.—Birds in this group, and their nests and eggs, are to be protected absolutely during the close season from the 1st March to the 31st July. (The Woodcock is to be protected from the 1st February to the 31st August, and the owners or occupiers of land may take the eggs of the Lapwing thereon up to the 15th April.)
>
> Category III.—Birds in this group, but not their nests and eggs, are to be protected during the close season from the 1st March to the 31st July except against the owners or occupiers of the land concerned and their accredited agents.

The birds included in the first and second categories respectively are listed in the schedules to the Bill, and the third category includes all the other birds. Roughly speaking, the birds in the first category are either species which are relatively rare or species of great usefulness, such as the owls, which it is desirable to encourage. Those in the second category are species which have not been considered quite worthy of the first but require special protection during the breeding

season. The Home Secretary or the Secretary for Scotland, as the case may be, is to be given power to transfer birds from one category to another or to change the dates of the close season. He may do this by general order or, with the consent of the local authorities, by local order affecting only a particular district; and with the consent of the owner and occupier of the land he may make a special order in support of an endeavour to create a bird sanctuary, even to the extent of giving all birds in the sanctuary the full protection of Category I. In exercising these functions the Secretary of State is to be assisted by an advisory committee.

The Bill also contains a number of special provisions, some of which are new and others of which are retained from existing enactments. The use of certain types of trap is to be prohibited altogether; the use of mechanically propelled boats or of aircraft is to be prohibited as an aid to killing or capturing birds; the capture of birds on highways, commons, and public places is to be prohibited; the killing or capture of birds on Sunday is to be prohibited; and the catching of birds alive is to be prohibited except under licence granted by the competent local authority. Lastly, the liberation of imported birds is to be permissible only with the authority of the Secretary of State, a wise provision aimed at the prevention of interference with the balance of nature.

The great advance in legislation of this kind which is marked by this Bill, however, lies in its application not only to offenders caught red-handed but also to all persons found in possession of birds, parts of birds, nests, or eggs which may be presumed to have been illegally taken. The onus of proof is to be thrown wholly on the possessor in the case of birds, nests, or eggs in Category I. and nests or eggs in Category II., and also in other cases during the whole of the close season except its first fortnight. Further, every taxidermist and dealer is to be compelled to keep a register giving all particulars of specimens passing through his hands which come under Categories I. and II. If this measure becomes law we may therefore hope to see an end of the scandal that the skins and eggs of some of our rarest and most strictly protected birds may be seen openly displayed in the taxidermists' windows or publicly advertised in the catalogues of dealers. Similarly, it will become an offence to sell or possess "plovers' eggs" after April 20 (allowing five days' grace from the beginning of the close season specially determined as regards the taking of these eggs).

The Secretary of State is to be empowered to grant special licences to kill or take protected birds or to take their eggs or nests either for scientific purposes, for the protection of crops, property or fisheries, or for other special reasons. The potential exemption from the law in favour of scientific purposes is a useful new provision, but it is to be hoped that the power will be very sparingly exercised in view of the great amount of useless collecting, especially of eggs, which masquerades under the name of science.

The Capillary Blood-Vessels.

The Anatomy and Physiology of Capillaries. By Prof. August Krogh. (Silliman Memorial Lectures.) Pp. xvii + 276. (New Haven: Yale University Press; London: Oxford University Press, 1922.) 13*s*. 6*d*. net.

EVERY cell of the body is brought into material relationship with all other cells in virtue of the existence of a common medium, the blood, which is maintained in constant circulation throughout the body. Substances absorbed into the blood from the exterior, either through the external or internal surfaces of the body, are thus brought round and presented to every cell, to be taken up or rejected according to the needs of the latter. In the same way the products of the chemical changes occurring in any cell are distributed to all other cells, so that the blood represents the internal environment integrating the metabolic activities of all parts of the body. The interchange between blood and tissues takes place only in the capillaries and smaller veins, so that we may say that the whole vascular system—heart, arteries, and veins—exists to ensure an adequate passage of blood through the capillaries. It is therefore rather surprising that the physiology of the capillaries has been comparatively neglected until the last few years. There have been isolated observations with regard to their structure and contractility and the properties of their walls. Some twenty-five years ago, when the question of lymph production and absorption was brought into prominence by the researches of Heidenhain, the functions of the cells forming the capillary walls were hotly debated, but after a few years, interest in the matter died down, and physiologists failed to appreciate or to follow up the many other problems concerning the capillaries which were implicit in the problems of lymph production.

By a study of injected specimens, or of the circulation in the lung or web of the frog, it can be seen that an arteriole breaks up into a large number of capillaries, each of which may have a diameter approximating to that of the arteriole. The relations in this part of the circulation have thus often been compared to those in a narrow stream flowing into a lake, and it has been tacitly assumed that the circulation through the capillary network as well as the state of dilatation

of the vessels forming this network were simply functions of the general blood pressure driving blood through the arteriole and of the state of contraction of the arteriole itself.

In reading the views on the circulation which were general before the discoveries of Harvey, we are often filled with astonishment that men endowed with mighty intellects, like Leonardo da Vinci, could not see what seems to us so self-evident. It is difficult to comprehend how any one could dissect the heart and be familiar with the effects of wounds of different parts of the body and fail to perceive the meaning of the valves in the heart and the course of blood through this organ. Yet we ourselves every day are equally blind. It is self-evident that the colour, say, of the skin, depends not on the amount of blood in the small arterioles but on the fulness of the capillaries. Every one knows that the capillaries may be overfilled together with constricted arterioles, giving rise to blue cold skin, or that the capillaries may be less full but with a vigorous circulation through dilated arterioles, so that the skin is warm and of the normal colour. These two observations should be sufficient to show that the state of dilatation of the capillaries is not dependent only on the condition of the arteries. Even a lifetime devoted to science and research seems incapable of preventing us from accepting familiar appearances without trying to understand them. It is not until some one puts a definite question and our curiosity is aroused that we become aware of a problem to be solved. In science it is the question that matters: the solution can always be found.

The recrudescence of interest in the capillaries occurred suddenly, many observers being led to the subject by the most diverse considerations. Among these Ebbecke was perhaps the most directly interested in the capillaries themselves. H. H. Dale was led to infer independent changes in the capillaries from his observations on the effects of histamine. Krogh, continuing his researches on respiration, found it necessary to consider the volume of the capillary circulation required for supplying sufficient oxygen to the working tissues. Then, during the War, the committee appointed by the Medical Research Council to investigate the causation of surgical shock was led to ascribe the main part in the production of this condition to the abnormally dilated state of the capillaries. Thus from all sides the attention of physiologists was focussed on these structures. As a result we can boast of a very large accession to our knowledge not only of the capillaries but also of the factors determining the supply of blood to the tissues under varying conditions.

The volume under review, by the man who has perhaps done more than any single physiologist to advance our knowledge of the capillaries, not only gives a connected account of our present knowledge, but also adds to this a large amount of original work which has been previously unpublished. Prof. Krogh starts with an account of the anatomy and distribution of the capillaries. He shows that in muscle, for example, the number of capillaries which are open varies from time to time according to the activity of the muscle. In a muscle of the horse there are about 1350 capillaries in every square millimetre of transverse section. The transverse section of an ordinary pin is about half a square millimetre. We get an idea of the extraordinary subdivision of the blood supply within a working tissue when we consider that within a structure of the size of a pin there are 700 parallel tubes carrying blood, in addition to about 200 muscle fibres. In smaller mammals, such as a guinea-pig, the maximum number of capillaries per square millimetre is about 4000. This means that an enormous surface of blood is available for interchange to take place with the tissue cells. Krogh makes the following calculation: "Supposing a man's muscles to weigh 50 kilograms and his capillaries to number 2000 per square millimetre, the total length of all these tubes put together must be something like 100,000 kilometres or two and a half times round the globe, and their total surface 6300 square metres."

The author makes a plea for further work on these lines. There is a rich field for the anatomists in such quantitative anatomy, especially if the problems attacked are chosen according to their importance for the normal functions of the body.

Krogh then shows by various means that the capillaries are endowed with an independent power of contractility, and that this is due to the existence of special kinds of muscle cells present in all capillaries and apposed to the outside of their thin endothelial wall. It is noteworthy that these cells were described so long ago as 1873 by Rouget, but the observation was disregarded and soon forgotten.

In the following lecture the author deals with the innervation of the capillaries. Here again histologists long ago described a rich supply of fine non-medullated nerve fibres, but the physiological significance of these fibres has been revealed only in the last few years. The innervation of the capillaries is of two kinds. In most cases stimulation of the sympathetic provokes contraction. They are also under the influence of the antidromic impulses, which cause dilatation, and, as Bayliss has shown, can be excited in the sensory fibres of the posterior root

and peripheral nerves. It seems that at their periphery these sensory fibres form a branching network, which in some of its functions resembles the diffuse superficial nerve network so widely distributed in the invertebrata. Stimulation of the surface, especially if painful, causes a dilatation of capillaries and small arteries which spreads for some distance round the stimulated spot. There is no evidence that nerve cells are involved in this local reflex, which is therefore regarded as an 'axon reflex.' The redness produced by the application of mustard to the skin is an example of this kind of reaction. If pronounced it may go on to the production of increased transudation of fluid from the affected capillaries and to the appearance of a blister.

After dealing with the local response of the capillary wall to mechanical and chemical stimulation, Krogh proceeds by a series of carefully thought out experiments to the demonstration that, throughout life, the calibre of the capillaries is regulated by some diffusible substance present in the blood, and he tracks this substance finally down to the internal secretion of the posterior lobe of the pituitary body. Perfusion of a frog's limb with Ringer's fluid causes wide dilatation of the capillaries and production of dropsy. If, however, the minutest trace of the pituitary hormone is added to the perfusion fluid, the capillaries retain their normal size and no œdema results.

Having arrived in this way at a knowledge of the factors affecting the calibre of the capillaries and the volume of the flow through the capillaries in any part, Krogh then proceeds to consider the bearing of these results on the main functions of the capillaries, namely, the nutrition of the tissues, the giving off of oxygen from blood to tissue cells, the taking up of carbon dioxide, the exchange of dissolved substances, and the production and absorption of lymph. In a final chapter he deals with various miscellaneous questions closely associated so far as regards their mechanism, such as the production and absorption of intra-ocular fluid, the condition known as surgical shock, and the causation of weals and urticaria under the influence of poisons or in persons of the so-called 'vaso-neurotic' disposition.

It is impossible within the limits of a review to do justice to the wealth of new facts and points of view brought out in the course of these lectures. We feel from the outset that we are starting on a voyage of exploration with the author. In every new step our curiosity is aroused before we are presented with the solution. At the same time we are conscious of the intellectual dangers which beset the explorer in these fields. The author states: "The problems of physiology are so complicated that, to put it tersely, one cannot expect to be able to reason correctly from the facts for more than five minutes at a stretch"—a healthy state of mind and very similar to that expressed by Harvey when he says that he "began to think with Frascatorius that the movement of the heart was known to God alone." But such difficulties and dangers only add to the joy of the chase, and we read the book with somewhat the same fascination and interest that our forefathers must have felt when presented with the immortal treatise of Harvey.

The book is written clearly and simply. We can conceive no better book to put into the hands of a student to arouse his interest in the advancing fringe of physiological knowledge and to acquaint him to some extent with the joy and spirit of research.

E. H. STARLING.

Thermodynamics and Chemistry.

(1) *Thermodynamics and the Free Energy of Chemical Substances.* By Prof. Gilbert Newton Lewis and Prof. Merle Randall. Pp. xxiii+653. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 25*s.*

(2) *Theoretical Chemistry from the Standpoint of Avogadro's Rule and Thermodynamics.* By Prof. W. Nernst. Fifth edition. Revised in accordance with the eighth-tenth German edition, by L. W. Codd. Pp. xx+922. (London: Macmillan and Co., Ltd., 1923.) 28*s.* net.

(1) FOR many years back the published researches of G. N. Lewis and his collaborators have occupied a prominent place in the branch of science dealing with the application of thermodynamics to the solution of chemical problems. The book now under review, of which he and his co-worker, Merle Randall, are joint authors, collects and summarises these researches and places them in position in the general framework of thermodynamics. For this alone all interested in matters pertaining to physico-chemical theory would owe them thanks, but the debt is increased by the fact that no better account of modern chemical thermodynamics than appears in this book can be placed in the hands of advanced students.

The treatment, while remaining in some ways conventional, has an individual freshness which makes the volume much more readable and interesting than most treatises on the subject. The material is divided into three parts, the first treating of the foundations of thermodynamics, the second dealing with the special methods of applying the fundamental principles to chemical problems, and the third being devoted to a systematic consideration of the data of thermodynamic chemistry. As might be expected, the notions of

"fugacity," "escaping tendency," and "activity" play a great part in the authors' development of the thermodynamics of simple substances and solutions, both non-conducting and electrolytic. The galvanic cell and single potentials receive adequate treatment, and a long chapter is devoted to the Third Thermodynamic Principle and the Chemical Constants of Nernst. The chapters of the last section of the book deal systematically with the entropies or free energies of chemical elements and their chief compounds. It is in this section that the book differs essentially from all its predecessors. So far as data are available they are utilised to calculate the changes in free energy attending important chemical reactions. Thus, under the heading "water" there is discussed the free energy of formation of water (*a*) from measurements of its dissociation at high temperatures, (*b*) from the dissociation of silver oxide, (*c*) from the dissociation of mercuric oxide, and (*d*) from the equilibrium of the Deacon process. Based on the mean of the independent and concordant values obtained by these four methods, a final value for the free energy of formation of liquid water is given. The free energy changes in the vaporisation and solidification of water are discussed, and finally the free energy of formation of the hydroxide ion. A table is given of standard free energies of formation at 25°, together with instructions for its use and numerous examples.

While admiring the skill and clearness with which many abstruse conceptions are brought before the reader, we must direct attention to a statement which, if not exactly erroneous, is certainly misleading. The authors (p. 115), after defining change of entropy, say: "Thus entropy has the same dimensions as heat capacity, and may be expressed in calories per degree." Again (p. 144), calculating the difference of entropy between solid and liquid mercury at the constant temperature of its freezing-point, they say: "We have from Equation (1) $\Delta S = \Delta H/T$. If ΔH is the heat of fusion of one mol, namely 560 cal., and T is 234·1, we may write $\Delta S_{234 \cdot 1} = 560/234 \cdot 1 = 2 \cdot 39$ cal. per deg." Surely there is an essential difference between $\Delta H/\Delta T$ (heat capacity) and $\Delta H/T$ (entropy); and surely the words "per degree" imply that the temperature is variable, which is here not the case. Such minor lapses as the above are most infrequent, and we have nothing but praise for the book in general. The formulæ are clear, and the notation employed is consistent, although not always in accordance with the table of International Physico-chemical Symbols. A good index is a valuable adjunct to the volume.

(2) A cordial welcome will be given to the new edition of Nernst's "Theoretical Chemistry." Written by one who is a master of research and of exposition, the book has been the guide of many generations of serious physico-chemical students, and nothing better of its type is ever likely to appear. It is not everywhere easy reading, but close study of the text will always provide an ample reward. In the present edition the chapters on radioactivity and the theory of the solid state have been largely rewritten, and sections have been added dealing with the structure of atoms and the application of X-rays to the determination of molecular dimensions. The translator, by not following the German text too slavishly, has provided a version which is both readable and accurate, though finer shades of meaning are not always faithfully reproduced: thus (p. 767) *Zusammenbacken* is translated by *solidification*, (p. 885) *Wechselwirkung* by *conversion*, (p. 874) *höchstwahrscheinlich* by *certainly*. It might be worth the attention of the publishers to consider the use in future editions of italic letters for algebraic quantities, as in the German original, instead of Roman letters, as in this translation. The former catch the eye better and facilitate reading.

A Scientific Introduction to Biology.

Elements of Plant Biology. By A. G. Tansley. Pp. 410. (London: G. Allen and Unwin, Ltd., 1922.) 10*s.* 6*d.* net.

TO write a text-book of botany is nowadays no easy task. The subject itself has grown in many directions, and it demands some knowledge of all the main branches of science as a preliminary to tackling even the simpler problems with which it confronts the student. A book intended for use in junior classes in a university must obviously then be the outcome of careful sifting and artistic synthesis of raw material if it is to be of any real value, and especially is this true when the demands of the student of medicine have to be satisfied. Botany, properly presented, forms perhaps the best introduction to biology for the purpose of the medical student, but how often when he has asked for bread has he been put off with unprofitable and altogether unattractive stones!

A modern introduction to botany ought to aim at affording some real insight into the working mechanism of life, and to make it possible to understand, at any rate, the more outstanding features of that mechanism as it behaves when in action. The machinery is vastly complex, and we have only been able as yet to certainly know fragments of the factory-processes that go on so swiftly and so smoothly within the plant cell. But it is possible, even now, to pick out and illustrate those processes by judicious selection of material, and so vividly to portray them in their larger outlines.

In his "Elements of Plant Biology" Mr. Tansley has certainly achieved a great measure of success in discharging a task beset with difficulties, and his book deserves to be widely read, for it possesses a certain indefinable, but none the less real, quality of distinction. The author has thought out his subject-matter well, and he has succeeded better, we think, than any of his predecessors in giving, on elementary lines, a clear and comprehensive account of the main features of plant life regarded from a truly scientific point of view. His mode of exposition is clear and his choice of material admirable, and thus, with remarkable freedom from esoteric technicality, he has produced a volume that really does provide the student with what will stand him in good stead, no matter what branch of biology he may ultimately elect to follow up. Furthermore, the book may be recommended with no less confidence to those who want to know something of some of the most important tendencies in modern biology, even if their main interests happen to lie in quite other fields.

The opening chapters touch briefly, and very clearly, on those physical and chemical aspects of the subject which are so essential to any real understanding of the living organism. The cell, its structure, its modes of reproduction, and so on, is sufficiently described, and its marvellous variety, both in form and development, is illustrated by well-chosen examples, special prominence being accorded to essentials, whilst details which, for the purpose of this book, are of less moment have been wisely passed over. A good account is then given of the leading and most generally interesting facts of structure and function as displayed in the various main groups of the vegetable kingdom, the whole treatment being so worked out as to enable the reader to obtain a comprehensive, if elementary, grasp of the chief evolutionary story of plants.

It is possible that a chapter on genetics might lend more completeness to this admirable volume; but with the object the author had more especially before him when writing it, possibly the omission was deliberate. Moreover, he does, in his closing chapter, briefly discuss the larger aspects of evolution, and the present writer especially welcomes the expression of opinion that "there is no bar to the appearance of characters which are of no *use* to the organism, nor even of characters which are disadvantageous to it, *provided they do not handicap the organism sufficiently to destroy its chances of continued existence*." This sentence (the italics are the author's) is in real accordance with the facts as they may be gathered from a study of plants actually growing in the open, and it represents a point of view which it is well to emphasise in the face of much false doctrine based on fanciful teleology. Lucretius, regarding the matter from a somewhat different angle, has well said in his "De Rerum Natura" (iv. 834-5):

> Nil ideo quoniam natumst in corpore ut uti
> Possemus, sed quod natumst id procreat usum.

J. B. F.

Kamerlingh Onnes and his Laboratory.

Het Natuurkundig Laboratorium der Rijksuniversiteit te Leiden in de Jaren 1904–1922. Gedenkboek aangeboden aan H. Kamerlingh Onnes, Directeur van het Laboratorium bij gelegenheid van zijn veertigjarig Professoraat op 11 November 1922. Pp. iv+458. (Leiden: Eduard Ijdo, 1922.)

AT a recent lecture given in London by Prof. H. A. Lorentz, Sir William Bragg made the happy remark that Holland, per square mile of its land—and water!—produced more eminent physicists than any other country. Amusing, and true. The appearance of the volume with the above title is another reminder of how true it is. Surely it is almost, if not quite, without precedent that it should fall to the lot of the same scientific investigator to have his work commemorated twice during his lifetime. Yet this is what has happened here. In 1904 there appeared a book, produced by his colleagues, to celebrate the twenty-fifth anniversary of the bestowal of the title of doctor on Heike Kamerlingh Onnes. The name of that book is identical with that of the present one, except for the dates—1882 to 1904; and in its introduction, if a free translation from the Dutch may be permitted, its purpose is described as "a review of what by him—through his inspiration, under his direction, by means of the apparatus he has assembled, and from his learning—has been added to the advancement of science."

It has appeared to the committee responsible for the new commemoration—Prof. Zeeman being the chairman and Prof. Lorentz himself a member—that the occasion would be served best by bringing out what Prof. Lorentz calls a "second edition," dealing with the work in Prof. Onnes' laboratory during the period 1904–1922, a period which includes the successful liquefaction of helium in 1908 and the well-known subsequent advances in the attainment and use of low temperatures. The cryogenic laboratory at Leyden has for some years become "an international institution for scientific investigations at very low temperatures"—a fact made evident by the names of those who have worked there and contributed papers to this volume. The description given by Dr. Crommelin indicates what a magnificent and well-organised laboratory it now is; but, until the enlarged building was completed and opened in January

1921, lack of space apparently added great difficulties to the work, and it is significant of the capacity of Prof. Onnes and those who have laboured with him that the output of valuable results has been so profuse. The new laboratory is indeed a fitting monument to a great man.

The book is, appropriately enough, mainly in Dutch, but each contributor has, in fact, written in his own language. Prof. Lorentz has contributed the foreword, in which he pays glowing tributes to his colleague. There are five chapters, of which the first contains articles descriptive of the laboratory itself. The late Prof. Kuenen describes the international character of the work, and Dr. Crommelin, upon whom seems to have fallen a lion's share of the labour of production, gives a very complete picture of the buildings, equipment, apparatus, and methods of work. Each of the four remaining chapters deals with a special field in which low temperatures have been applied. W. H. Keesom and E. Mathias, among others, contribute papers on thermodynamic investigations with gases. Researches on magnetism at low temperatures, carried out by himself and Prof. Onnes, are described by P. Weiss. Chapter IV. is entitled "Investigations in Optics, Magneto-optics, and Radioactivity," and contains papers by Zeeman, Jean Becquerel, Ehrenfest, and Mme. Curie. The last chapter, which refers mainly to the super-conductivity displayed by metals at very low temperatures, and contains a paper by Einstein, includes also reviews of results connected with the Hall effect, piezo-electricity, and other electric phenomena. There are numerous illustrations and diagrams; a few sketches appear also, including a frontispiece portrait of Prof. Onnes, drawn it is not clear whether by himself or by a near relative of the same name.

It is altogether a book worthy of the occasion; it properly impresses one with the exceptional greatness of the work and of the man. Strictly, of course, it is a tribute from his colleagues and students, but it is one in which, without distinction of nationality, we should all be ready to join unreservedly.

Thirty Years of Public Health Work in Manchester.

Observations on the History of Public Health Effort in Manchester. By Dr. James Niven. Pp. vii+230. (Manchester and London: John Heywood, Ltd., 1923.) n.p.

THE retirement of Dr. James Niven, the medical officer of health of Manchester, has led to the preparation by him of an intensely interesting account of public health effort in Manchester since 1894, when he first became responsible for the official health work of this city. The story is one which will be read with interest and admiration, not only by those colleagues in the public health service who for many years have looked to Dr. Niven for light and guidance in the application of science to preventive medicine, but also by many others who know that sanitary progress in this period has been as great as, or even greater than, the progress in life-saving surgery.

Here we can merely direct attention to a few salient points, advising all who can obtain a copy to study the report in detail.

In the stride forward of preventive medicine, there has been a tendency to have regard solely to specific infection as a source of disease; but Dr. Niven wisely, in the outset of his report, expresses the well-founded view that by far the most important influence which has governed the improvement of the public health in Manchester, apart from economic conditions, has been the removal of organic filth, whether within or without the habitations of the people. The story of improvement in this respect is vividly told, the region of least success being that of emission of smoke from chimneys.

The general result of all the reforms achieved, as shown in vital statistics, comparing the period 1891–95 with 1916–20, is that the general death-rate has declined 40 per cent., typhus fever is extinct, the death-rate from enteric fever has declined 92 per cent., diarrhœal diseases 74 per cent., the rate of infant mortality 44 per cent., and pulmonary tuberculosis 42 per cent. The story as regards enteric fever and diarrhœa is especially impressive. The abolition of pail-closets, the reform of stable-yards, the aid furnished by bacteriology in the diagnosis of enteric fever, the recognition of carriers and shell-fish as important sources of infection, and steady action against the domestic fly, have all borne their share in securing the vast improvement which is recorded.

Dr. Niven was the pioneer of administrative control of tuberculosis in Great Britain, and his review of progress made is especially important. In defending direct action against the disease as distinguished from indirect action against slum dwellings, he holds the balance very fairly. He agrees that history and experience alike point to the relief of economic pressure as the most powerful weapon in combating tuberculosis; but attack solely from this point of view erroneously assumes that economic conditions can be altered at will. This being so, there is no excuse for neglecting direct action founded on an intimate knowledge of the disease. There is the further point that we are concerned with a vicious circle. Not only does poverty favour tuberculosis, but it is itself a poverty-

making disease, some 40 per cent. of existing poverty having been estimated to be due to it. In a full discussion of housing difficulties, Dr. Niven points out the impossibility of securing satisfactory housing in central districts on economic lines, and in this connexion suggests that the necessary expenditure might be diverted from what is wasted on alcoholic drinks. He asks, "Can there be any doubt that the liquor trade paralyses the hands of the social reformer and keeps the people poor?"

Only a few of the important subjects discussed in this valuable review of public health progress have been mentioned; but we trust that the attention now directed to it may lead to its study by many who at present realise inadequately the vast strides already made in the prevention of disease and in the improvement of the public health.

The Ichthyosaurians.

Die Ichthyosaurier des Lias und ihre Zusammenhänge. Von Friedrich von Huene. Pp. viii + 114 + 22 Tafeln. (Berlin: Gebrüder Borntraeger, 1922.) 25*s*.

BARON F. VON HUENE is well known by his numerous writings on fossil reptiles of strange and rare types which are represented by more or less fragmentary specimens. He has now turned his attention to the comparatively familiar ichthyosaurians, of which, perhaps, more nearly complete skeletons occur in museums than of any other reptiles. As he remarks, the osteology of this group is now rather well known. He therefore devotes his work chiefly to a definition of the species, with an attempt to arrange them in genera and to determine their relationships. He has made many new observations on the specimens from the Lias of south Germany, of which he publishes important illustrations. In this research he acknowledges especially the valuable help of Dr. Bernhard Hauff, of Holzmaden, whose fine preparations of Liassic reptiles and fishes are now scattered through many museums.

Baron von Huene adopts the usual classification of the ichthyosaurians into those with the fore paddles broad and those with the paddles long and narrow. He also considers that these two groups remain distinct from the beginning to the end of the career of these marine reptiles. He recognises and names more genera, however, than have hitherto been supposed to occur, and his taxonomy is not likely to meet with general approval. Ichthyosaurus, for example, altogether disappears as a generic name; and other generic names already exist having priority over some of the new names proposed. The taxonomy is indeed the least acceptable part of the work.

The stratigraphical distribution of the ichthyosaurians in the Lias of south Germany is shown in a table, and it would be interesting to make an equally detailed study of the distribution of the species in the several zones of the Lias in England. Except the typical species of Ophthalmosaurus from the Oxford Clay, the later ichthyosaurians are still known only by comparatively fragmentary specimens.

The author concludes his work with a large table of outline sketches to illustrate the evolution of the ichthyosaurians from their first appearance in the Middle Trias to their disappearance in the Upper Cretaceous. At the beginning he places the small Mesosaurus, of Permian age, which he considers may be related to the semi-aquatic primitive ancestor of the whole group, which still remains unknown. The Triassic forms are represented as long-bodied, with the backbone only slightly bent downwards where a small caudal fin arises. The caudal fin is completed before the end of the Liassic period; and it becomes more effective as a propeller by the shortening of the caudal pedicle in the Upper Jurassic forms. The only Cretaceous species sufficiently well known for restoration is represented as again slender, with a comparatively small though complete caudal fin.

The volume is excellently printed and illustrated, and we commend it to the notice of all students of vertebrate palæontology. A. S. W.

Our Bookshelf.

Die steinzeitlichen Stationen des Birstales zwischen Basel und Delsberg. Von Fritz Sarasin. Prähistorischer und anthropologischer Teil von Fritz Sarasin. Paläontologischer Teil von H. G. Stehlin, unter Mitwirkung von Th. Studer (Aves). Mit 32 Tafeln und 20 Textfiguren. Neue Denkschriften der Schweizerischen Naturforschenden Gesellschaft. Band liv. Abh. 2. (Basle, Geneva und Lyons: Georg und Co., 1918.) n.p.

THE above volume, only recently issued though dated 1918, contains some 290 pages of text, with 32 full-page illustrations at the end. There are also some 20 figures in the text giving sections, maps, and the like. A full and careful account of a number of diggings just south of Basle is given, including a description not only of the archæological finds, but also of the mammalian and bird remains. The whole forms a useful addition to our knowledge of prehistoric times in this region.

The first part of the volume is devoted to a description of finds from a number of caves. The industries recognised are Neolithic, Azilian, and Magdalenian. Owing to the area being outside the region of glaciation, the determination is done on purely typological grounds. A Neolithic burial (with skeleton complete) was unearthed, and a full account is given. In one instance "painted pebbles" were discovered in an Azilian layer. It is interesting to find these typical Azilian objects so far north. There is evidence of Azilian culture as far

north as West Scotland, but hitherto "painted pebbles" have only been found farther south. The latter part of the book is concerned with an account of some open-air Neolithic stations. The whole is completed by the inclusion of a very full bibliography, referring both to the archæology and to the palæontology.

The authors are to be congratulated on their explorations and on the publication—especially on having managed to include so many and such excellent plates. The area under discussion is of course restricted, but it is exceedingly important that the results obtained in various diggings should be carefully published, and not, as is, alas, so often the case, be either not published at all or merely noted briefly in some obscure review. The finds described in the above work are preserved in the museum at Basle. M. C. B.

The Practical Applications of X-rays. By Dr. G. W. C. Kaye. Pp. viii + 135. (London: Chapman and Hall, Ltd., 1922.) 10*s.* 6*d.* net.

THIS book is based largely on a course of Cantor Lectures given by the author, and is primarily concerned with the many practical applications to which X-rays are put at the present time; this term is, however, not meant to include their medical applications.

Rather more than one-half of the book is devoted to a description of the methods of production of X-rays and of their measurement; such a liberal proportion of space will generally be welcomed by those seeking to apply X-rays for themselves. During the War, X-rays were used successfully to detect flaws in aeroplane parts, and the author shared very largely in this work, of which some good illustrations are shown. The main industrial application may perhaps be said to be in the examination of metal castings, and the recent technical developments, whereby X-rays of very short wave-length may be obtained, should see a widening range of application here.

X-ray examination shows some very striking differences between ancient and modern pictures; these differences are mainly due to the pigments and primers employed by the artists; present-day pigments are not nearly so opaque to X-rays as the metallic pigments used by the earlier painters. Some illustrations from the work of Heilbron will convey sufficiently well to the expert the assistance he may expect from the radiologist in detecting the work of the vandal.

The volume contains in one appendix the two memoranda which have been issued by the X-ray and Radium Protection Committee on methods of safety, and in a second appendix a useful list of definitions of terms in common use in X-ray and electro-medical literature.

Principles and Practice of X-ray Technic for Diagnosis. By Dr. John A. Metzger. Pp. 144. (London: H. Kimpton, 1922.) 14*s.* net.

THE author's aim is "to put into the hands of the student and operator a formula on which to base his work in order that he may obtain better results and thus be able to reach a more correct diagnostic interpretation."

We must confess to a failure in finding the "formula." The book opens with a glossary of terms and this is scarcely reassuring; for radiography we read "same as skiascopy," which is not defined; X-rays are said to be rays of unknown quantity; tension is defined as the tendency of electricity to overcome resistance.

On the second page of the first chapter the author discusses the use of gas and Coolidge tubes, but we are left wondering at what is meant by the following statement: "The difference between the tubes used with the high-frequency machines and the induction coil is one of the vacuum, and the additional cathode of the former to care for the inverse, while the difference between those for the induction coil and the transformer is that of a heavier target construction and lower vacuum of the one to care for the additional voltage and absence of an inverse."

The book is profusely illustrated, mainly in order to show the various positions of the patient which the author advises for different diagnostic purposes. Many of these are quite unnecessary, and three of them are duplicated in the text.

A Text-book of Intermediate Physics. By H. Moore. Pp. ix + 824. (London: Methuen and Co., Ltd., 1923). 22*s.* 6*d.* net.

THIS is a very complete text-book for intermediate students in universities. It is well printed, has many original illustrations, and is provided with an exceptionally good index of thirty-nine pages. Block type is used for the principal laws and conclusions, so that revision of his work on the part of a student is facilitated. The author has, however, unfortunately reproduced a number of the mistakes and incomplete statements of his predecessors. He confuses surface energy and surface tension, and on p. 149 he speaks of the weight of the liquid below the meniscus in a capillary tube being supported by the surface tension. He devotes more space than is desirable to old and discarded methods, *e.g.* Laplace and Lavoisier's expansion apparatus, p. 173, and specific heat apparatus, p. 218, while no information is given as to how the expansion coefficient of a gas is calculated from observations with accurate apparatus, p. 191. On p. 254 the saturation vapour pressure over a solid is incorrectly shown. The part on light is good, but there seems no reason for omitting old sight from the list of defects of the eye on p. 458. There appears to be no mention of the magnetic circuit, and the diagrams of dynamos on pp. 739 and 741 may account for the necessity of silence on the subject.

Abriss der Biologie der Tiere. Von Prof. Dr. Heinrich Simroth. Vierte Auflage, durchgesehen und verbessert von Prof. Dr. Friedrich Hempelmann. Teil 1. Entstehung und Weiterbildung der Tierwelt. Beziehungen zur organischen Natur. (Sammlung Göschen Nr. 131.) Pp. 147. (Berlin und Leipzig: Walter de Gruyter und Co., 1923.) 1*s.*

THIS is a revision of Simroth's "Sketch of the Biology of Animals," and a very interesting little book it is. We do not think that the text corresponds particularly well with the sub-title, which might be translated "Rise and Progress of the Animal Kingdom: Relations to Organic Nature"; and in the catalogue these are the titles of two separate volumes. But that is a trivial detail. The little book before us deals mainly

with the following subjects—the relations of animals to gravity and their locomotion in various media; light, colour, and luminescence; equilibration, hearing, and touch; chemical influences; the influence of heat and cold; animal electricity; and respiration. This is a lot to cover in 150 small pages, but we are bound to say that the treatment is very effective. The chapters are simply illustrative, and thus they remain interesting. Most of the illustrations are fresh.

Origine de la vie sur le globe. Par Julien Costantin. (Bibliothèque de Culture générale.) Pp. 192. (Paris: Ernest Flammarion, 1923.) 4.50 francs net.

The problem of the origin of organisms upon the earth continues to attract and to defeat the inquisitive spirit. Prof. Julien Costantin discusses it in various aspects: Had living creatures a beginning at all? If they had, what were the first organisms like? Did plants come before animals? Is there any clue in the so-called "life of crystals"? He also inquires into the meaning of animate organisation, the importance of colloids, the chemistry of the cell, the puzzle of cell-division, the processes of growth and development.

The chapters are all careful and clear, but they do not lead us to any solution. The author concludes that there must have been pre-Cambrian spontaneous generation, that it is very improbable that it ever occurred again, that there is no hint of its occurring now, that green algæ were the first organisms, and that there is nothing to show that they were preceded by bacteria, that the hypothesis of cosmozoa only shelves the problem, and that their hypothetical arrival on the earth should have been followed by several distinct lines of evolution, which is not what the facts indicate. To expect to effect the synthesis of living matter in the near future is "perfectly ridiculous."

University of Oxford: Institute for Research in Agricultural Economics. An economic survey of a rural parish. By J. Pryse Howell. Pp. 31. (London: Oxford University Press, 1923.) 1*s*.

This little survey, extending to 25 pages only, is quite useful as an example of the kind of inquiry that could well be made in many more of our country parishes. We are told nothing of the location of the particular parish, not even its county, and the work loses much of its value in consequence. But the survey gives a picture of a village, presumably in Wales, where the houses are let at annual rentals of 25*s*. upwards, and where the inhabitants apparently produce most of what they need for themselves, since the sales from the farms work out to about £50 per annum only per person employed. It is interesting and should prove instructive to any rural or urban dweller interested in the human side of agriculture.

Tychonis Brahe opera omnia. Edidit I. L. E. Dreyer. Tomi quinti, fasciculus posterior. Pp. 217-343. (Hauniae: Libraria Gyldendaliana, 1923.) n.p.

This is a supplement to vol. v. of Tycho's collected works. It contains several examples of Tycho's observations of the sun and planets, and his discussion of them, assuming that the sun (the centre of the planetary motions) itself goes round the earth. These will always remain classic, from the part they played in establishing Kepler's Laws, and later Newton's law of gravitation.

A map of Huen is reproduced.

The table of longitudes and latitudes reminds us how inaccurate the knowledge of longitude was in Tycho's time; for example, Alexandria is placed 36° east of London.

The volume closes with twenty-five pages of useful editorial notes. A. C. D. C.

Scientific Method: an Inquiry into the Character and Validity of Natural Laws. By A. D. Ritchie. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. viii + 204. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1923.) 10*s*. 6*d*. net.

Mr. Ritchie's book being a dissertation for the examination for a fellowship at Trinity College, Cambridge, is primarily designed to prove the extent and depth of the writer's reading. It leads us to hope much from Mr. Ritchie when he no longer needs credentials. The main scientific value of the book is perhaps that it reveals the type of mind the present Cambridge teachers are nurturing and the direction of research they are encouraging.

Traité de Psychologie. Par Prof. Georges Dumas. Tome 1. Pp. xiv + 964. (Paris: Félix Alcan, 1923.) 40 francs net.

The work under notice partakes more of the nature of an encyclopædia of psychological science than of a treatise on psychology. It is a reminder of the exuberant growth of the subject in our own time. It was designed by the late Théodule Ribot, and his preface is retained, but the present edition is under the direction of Prof. Georges Dumas, and he has secured as his collaborators a number of most distinguished workers, every one eminent in some branch of psychological science.

The Amateurs' Book of Wireless Circuits. By F. H. Haynes. Pp. 107. (London: The Wireless Press, Ltd., 1923.) 2*s*. 6*d*. net.

The amateur radio engineer will find Mr. Haynes's little work most instructive. The author begins with the simplest possible circuits and then introduces elaborations step by step until he arrives at many of the complicated arrangements used in practice. Standard symbols are employed and the diagrams are beautifully clear, so the gradual evolution of the systems can be very readily followed.

Questions and Problems in Chemistry. By F. L. Darrow. Pp. vii + 177. (London: G. Bell and Sons, Ltd., 1923.) 3*s*. 6*d*. net.

This book consists of a large number of very simple questions on chemistry, and may be found useful to teachers in schools. It is, however, more adapted for use with an American text-book, and adopts American spelling—"sulfuric," etc. The examination papers at the end are American, and in many ways the book will not fit in with English school methods.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Light and Electrons.

SIR OLIVER LODGE, in his survey of the problems connected with Ether and Electrons (NATURE Supplement, August 4), propounds the interesting question: "Does light generate an electron?" The hypothetical conversion of radiation into matter may, as he points out, accord with observed results as to the photo-electric emission of electrons. In particular the striking reciprocal relation between the energy of an electron and the energy of X-rays seems to justify his statement: "It is as if the same beta particle, that is, the same electron, had gone out of existence at one place, and been recreated at another, the intermediate link being constituted by specific radiation of a perfectly definite wave-length." Sir Oliver Lodge says further: "I know that the Bohr Theory of the Atom seems at first against these speculations. Electrons do appear to jump from one orbit to another, and thereby give out a certain quantum of energy. But this may be a supplementary, and not a contradictory statement."

In this connexion I should like to direct attention to a suggestion made by Prof. E. T. Whittaker in his paper on the quantum mechanism in the atom (Proc. Roy. Soc. Edin. vol. 42, p. 141, 1922). He points out that Bohr's theory of series spectra can be assimilated to the theory advanced in his paper in the following way. "In Bohr's theory let a negative electron E fall from an orbit of radius a_1 (position P_1) to an orbit of radius a_0 (position P_0). Now in the initial state of this system, which consists of the electron E at P_1, let us introduce two coincident electrons E' and E'' at P_0, one positive and one negative, so that they annul each other; and let us replace Bohr's conception of the fall of the electron from E at P_1 to E' at P_0, by the conception of the discharge of a condenser whose charges are E and E''; the discharge annihilates E and E'', and so leaves E' surviving alone at the end of the process, and is therefore equivalent to Bohr's notion of a translation of E to the position of E'."

The suggestion is easier to visualise if instead of the circling electrons of Bohr's theory we employ the stationary electrons obtained by introducing Langmuir's "Quantum Force" (*Phys. Rev.*, vol. 18, p. 104, 1921). The conception of the discharge of a condenser is not essential to the picture, and Sir Oliver Lodge may prefer to replace it by a mechanical vibration of the column of ether between E and E'', resulting in the production of what Silberstein has called a "light-dart." In speaking of the discharge of a condenser, as in speaking of the vibration of a medium, we are using figurative language, which is meant only to suggest an illustration of a process which is beyond the range of our experience.

One of the difficulties in Bohr's theory is to understand how the frequency of the radiation emitted in accordance with his fundamental frequency condition can be fixed as soon as the electron quits the first stationary state and before it has reached the final state. As Silberstein puts it: "Needless to say the founder of the new theory and his followers do not attempt to describe the mechanism of such an extraordinary performance, one, that is, that enables the atomic system to hit precisely upon the frequency required." Again in a recent letter Prof. C. G. Darwin (NATURE, vol. 111, p. 771, June 9) refers to the difficulty "that the quantum conditions determining the permissible Bohr orbits can only be explained physically by attributing to the electrons a knowledge of the future."

This difficulty—and the similar one which arises in connexion with absorption—seems to be diminished, if not entirely removed, by the suggestions put forward by Prof. Whittaker. On this view the emission of light originates not so much at the position P_1 as at the position P_0, where we may imagine an incipient crack in the ether developing under the influence of some external disturbance, say the approach of some other atomic system. There is here a suggestion of a discrete structure for the electromagnetic field (or ether) in the space surrounding an atom such as I have previously attempted to indicate in speaking of Faraday's magnetic lines as "Quanta."

In the present stage of the development of physics, when we seem forced to believe in two mutually contradictory theories of light (the undulatory and the corpuscular theory) at the same time, the wildest guess at a solution may be permitted. This must be my excuse for hazarding the suggestion that conceivably the "head" of the disturbance (derived from the negative electron E) spreads out as the light advances—the amount of spreading involved being a question requiring further investigation—whilst the "tail" (derived from a positive electron) retains to a greater extent its corpuscular character, and plays the part of one of Sir J. J. Thomson's "specks" as it follows the advancing wave-front. On this view absorption of radiation takes place when an electron grasps the light—in this revised version of Little Bo-Peep—by its "tail"!

H. S. ALLEN.

The University, St. Andrews.

Continental Drift and the Stressing of Africa.

As one among many geologists who (so it would seem) would welcome proof of an hypothesis of continental drift, but who cannot accept Dr. Wegener's peculiar opinions with regard to it, I recognise that we owe a debt of gratitude to Dr. J. W. Evans for showing us an ingenious way out of some of the difficulties that Wegener, albeit unintentionally, demonstrates rather than removes; none the less, the views of Dr. Evans on this subject appear to be open to question.

Dr. Evans states (NATURE, March 24, p. 393) that "there seems reason to believe that Africa is in the main the centre of a region of tension, due to the outward drift of continental masses," which, as he points out, is explicable as "drift from a region of comparatively low gravity to one of higher gravity." Following Osmond Fisher and Pickering, Dr. Evans sees no objection to the view that the Pacific depression is the scar left by the separation of the moon from the earth—a phenomenon which Sir George Darwin attributed to tidal action—and is inclined to follow Prof. Sollas in regarding the African protuberance as an unsuccessful attempt on the part of the earth to produce another satellite.

The birth of the moon is a piece of extremely ancient history, and the consequent stressing of Africa, if indeed there be any such consequence, must have started as soon as the moon's mass was lost, or, in the event of excessive resistance of sima to sial—an unlikely event if the postulated circumstances of the moon's origin be correct—as soon as

the rise in temperature resulting from the blanketing of the sea bottom, by sedimentary deposits, in the neighbourhood of land masses became sufficient considerably to reduce the rigidity of the basic sima beneath the continental shelves. The great thickness of the earliest sedimentary strata suggests that this condition was attained in very remote geological times; and in view of the slow progress the continents would make by this process of drift, it would appear that the degree of separation now attained by these land masses may be taken to point to a similar conclusion, even though a liberal allowance be made for lateral collapse along the margins of the separated tracts. According to this view, tensional structures should be dominant throughout the geological history of Africa.

Of other African territories I will say nothing, but with regard to Uganda, which lies, be it noted, in the heart of the continent and between two great rift valleys, tensional structures are astonishingly absent, or, at any rate, difficult to find.

Deposited on a basement of crystalline rocks which represents, in all probability, a great accumulation of archaic sub-aqueous deposits intruded upon and largely metamorphosed by ancient acid magmas that have incorporated much of the sediments, is a very thick series of shales and sandstones (usually more or less altered) of great antiquity but of undetermined age. These are part of what we once called the Argillite series (a tentative term now abandoned, see Ann. Rept. Geol. Dept. Uganda, 1920, p. 10); they constitute what we now call the Ankolian system. These rocks have suffered much from folding and are sliced up by tremendous faults. Owing to the want of easily recognised horizons within the system, it is usually very difficult to demonstrate the nature of these faults. There can be little doubt, however, that they are essentially compressional structures, and in every instance where the fracture contacts have been seen they have revealed overthrust faults. After this great phase of faulting, the Ankolian beds have been thrown into a series of complicated domes, the eroded remains of which were first described by me as *arenas* (*loc. cit.* p. 14). Some of these have been the subject of careful study by Mr. A. D. Combe (Field Geologist, Uganda Service), who has mapped them in detail. It is quite certain that these do not give evidence of tension, but quite the reverse.

Above the Ankolian, and deposited unconformably upon that system, is the Mityana series, consisting of thick accumulations of sandstones and conglomerates; these, too, have suffered from faulting, but to a lesser degree than the Ankolian. The nature of these faults is as yet undetermined. The Ankolian and the Mityana series have together been thrust up by an enormous bathylith (the Mubendi bathylith), the denudation of which has exposed the newer granite: this does not look like tension. Deposits revealing plant-impressions, possibly of Jurassic age, which appear to be the next in order of sequence, have been located in eastern Uganda; they occur in a syncline of no great size: the significance of this structure is uncertain. No other tectonic movements are as yet known in this country until we come to (probably) late Cretaceous and Tertiary times, when we have the doming of Uganda (the Uganda-Congo dome lying to the west of the syncline of Lake Victoria, which itself lies to the west of the Kenyan dome or anticline). This structure can scarcely be interpreted as tensional; yet at the time of its inception continental drift, if drift there has been, should surely have been well advanced. The first structures of more than purely local significance that have been interpreted as tensional do not make their appearance until about middle tertiary times, though the action which they signify continued until much later: I mean, of course, the rift valleys, and even these, at any rate so far as their first inception is concerned, are more easily accounted for by compression than by its opposite.

Here, with the Semliki (Semaliki the natives call it) and the Congo rift-scarp to my left, the Toro-Bunyoro escarpment to my right, and the Ruwenzori range behind me, I write sitting on the evidence, as it were, that proves, perhaps for the first time conclusively, the tectonic origin of the Albertine depression, and demonstrates beyond all doubt the amazing fact that early man knew the lake when it stood more than 1000 feet higher than it does now. A thousand-foot head on Lake Albert is impossible to-day, and has been ever since the differential drop of the Bunyoro scarp not only released the pent-up waters of Lake Albert, but gave birth to the Victoria Nile that connects, through Lake Chioga, the great Nyanza with the Albertine depression. All this is, in my opinion, more easily accounted for as a necessary consequence of compressional activity than as the direct result of tension.

The tectonics of the rift is too big a question to discuss in a letter, but it may be noted that all the evidence that I have been able recently to obtain in Toro and in the Bwamba country supports the view, generally held, that Ruwenzori is an upthrust mass. It is directly connected with the rift but very probably pre-rift in age. Now there is evidence to show that since the inception of the Albertine rift the bottom of the valley has sunk by two distinct major movements well separated in time. The sinkage has been pivotal with a maximum downthrow to the north-east, as has the subsidence of Bunyoro. That which has remained firm and helped in marked degree to hold the sinking bottom of the rift valley is the great faulted upthrust of the Ruwenzori range: this does not look like tension anyway.

I am afraid that exception must be taken to Dr. Evans's use of the term rift as applied to the separation tract between drifting continents. Thus used, the term is most applicable, but it has priority in Prof. Gregory's usage, which, though it may be less apt, is now unalterable. E. J. WAYLAND.

The Semliki Plain,
May 1.

Protozoa and Virus Diseases of Plants.

ATTEMPTS to discover the presence of a foreign organism in such diseases as tobacco-mosaic, tomato-mosaic, leaf-roll of potato, and numerous other similar infectious diseases have been the concern of botanists for many years. Although considerable knowledge has been gained as to the distribution of these diseases by insects such as Aphides, yet no causal organism has been observed with certainty, and the diseases have been classed accordingly as virus diseases. The failure to detect the presence of a foreign organism has naturally been a serious handicap in combating these diseases, many of which are of serious economic importance.

The appearance of a paper by R. Nelson entitled "The Occurrence of Protozoa in Plants affected with Mosaic and Related Diseases" (Agric. Expt. Station, Michigan, Bull. 58, 1922) is thus of great interest.

In this paper Nelson claims that protozoa are to be found in the phloem of plants affected by bean-mosaic and tomato-mosaic, and also in potato plants affected by leaf-roll, while such organisms are absent from the phloem of healthy plants.

Some of these organisms are described as possessing a single flagellum and an undulating membrane, others as biflagellate; their general resemblance to trypanosomes is also claimed.

When Nelson's paper was received in this country some few months ago, I was engaged in a study of the mosaic of hops, a disease probably to be classed as a virus disease. A search for protozoa similar to those described by Nelson was accordingly made in the phloem of hops thus affected. No such organisms were to be observed, but elongated deeply-staining structures having a marked resemblance to those figured by Nelson and described by him as protozoa were found, as shown in Figs. 1a, 1b. *In the case of the hop-mosaic these structures were undoubtedly degenerate nuclei*, for all transitions could be observed between them and the normal nuclei of the phloem. These degenerate nuclei were not observed in the phloem of healthy hop plants, but they were to be seen in the phloem of an unhealthy bean plant that had been kept some time in the poor light of a laboratory and the leaves of which were attacked by Botrytis (Fig. 1, *c*).

These results do not, of course, disprove the observations of Nelson as to the association of protozoa with virus diseases, for the diseases which he investigated have not been studied. Considering, however, how important the discovery of a causal organism in virus diseases would be, it seemed advisable to put on record the results obtained with diseased hops and beans.

Such results indicate clearly that the theory of the association of protozoa with virus diseases requires fuller evidence than has yet been supplied. It is to be noted that Nelson describes the protozoa in the plants he examined as usually existing singly in the cells, and as always elongated in the direction of the axis of the stem, *i.e.*, the organisms stand permanently on end in the plant. These somewhat remarkable results would find an easy explanation if the structures in question were no more than the degenerating nuclei of the elongated cells of the phloem.

FIG. 1.—Longitudinal sections of the phloem. *a* and *b*, a mosaic hop stem. ×1000; *c*, an unhealthy bean plant. ×600.

M. S. LACEY.

Department of Plant Physiology and Pathology,
Imperial College of Science and Technology,
South Kensington, S.W.7, August 8.

The Scattering of Light by Liquid and Solid Surfaces.

IT is a well-known fact of observation that most reflecting surfaces usually also scatter a little light and are thus rendered visible. The effect is usually dismissed, however, as due to dust or imperfect polish of the surface, and little attention has been given to the problem of determining whether, when these disturbing factors are eliminated, any scattering by the surface persists. Experiments carried out by the writer in collaboration with Mr. L. A. Ramdas to test this matter have led to some interesting results.

Freshly split cleavage faces of crystals show extraordinarily little scattering. In fact, it is found that a clean good piece of mica has surfaces which are invisible even when placed at the focus of a lens illuminated by sunlight against a dark background. This is what one would expect theoretically. Cleavage surfaces of rock-salt and Iceland spar are also good, though not so perfect. The conchoidal fracture-surfaces of quartz are relatively very imperfect optically. Blocks of thick plate glass when freshly broken open exhibit surfaces which apparently are quite smooth, but when illuminated by sunlight they show a blue superficial opalescence. Freshly-blown bulbs of glass when held in a strong light also show this surface opalescence very well.

Coming to liquids, the most interesting case is that of metallic mercury. After carrying out a series of chemical purifications, washing and drying the mercury and then distilling it in vacuum from one bulb to another and transferring it back again repeatedly, Mr. Ramdas succeeded in obtaining surfaces which were dust-free and chemically clean. When sunlight is concentrated on such a mercury surface in a vacuum, the focal spot shows a bluish-white opalescence, the scattered light when observed in a direction nearly parallel to the surface being very strongly polarised with the electric vector perpendicular to the surface and of nearly similar intensity in all azimuths. The opalescent spot when examined under a microscope appears perfectly structureless, showing that it is a true molecular phenomenon.

To test whether the surface-opalescence exhibited by mercury is due to the mobility of the dispersion-electrons usually assumed to exist in metals, or whether it is due to the rugosities of the surface caused by molecular bombardment, observations were also made with transparent liquids in enclosed bulbs made dust-free by repeated distillation. Various liquids tried, *e.g.* ether, alcohol, benzene, carbon tetrachloride, liquid carbon dioxide, all showed the surface-opalescence conspicuously under strong illumination. The character of the effect in these cases was, however, quite different from that shown by a clean mercury surface.

The surface-scattering by transparent liquids is undoubtedly due to the effect of molecular bombardment of the surface. It is much more intense when observed in directions adjacent to that of regular reflection and refraction than in other directions. It is less blue than the internally-scattered light, and shows remarkable changes in its state of polarisation with varying angles of incidence and observation. There were notable differences in this respect between the cases in which the light is incident respectively within and outside the liquid on the interface. There is a rapid falling off in the intensity of the surface opalescence when the angle of incidence is increased much beyond the critical angle. These facts clearly indicate that the effect shown by transparent liquids is essentially due to the imperfect planeness of the surface. The scattering by a metallic liquid surface, on the other hand, has probably a different origin, as suggested above.

The interface between two non-miscible dust-free liquids also shows strong opalescence under illumination. For the particular case in which the interfacial tension is very small or negligible, the opalescence becomes greatly exaggerated. Some observations by Mandelstamm (*Ann. d. Phys.* vol. 41, 1913) on the critical state of liquid mixtures are of interest in this connexion.

The experimental observation of the surface-opalescence of *water* presents special difficulties owing to the great ease with which this liquid catches dust and grease. The difficulties have, however, been successfully overcome and the effect satisfactorily demonstrated, both with water rendered dust-free in sealed bulbs and with the water-film on a clean block of melting ice kept free of dust by a gentle stream of gas blowing upon it.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta,
June 28.

On Continuous Radiation from the Sun.

PROF. J. Q. STEWART recently published in these columns (NATURE, February 10, p. 186) a very interesting communication on the optical and electrical properties of ionised gases. For some time past I have been engaged in investigations on similar lines, and I wish to direct attention to one important side-result. It is well known that in estimating the surface temperature of heavenly bodies (as has been done by Coblentz, Abbot, Wilsing and Scheiner, and others), from their continuous spectra, it is always tacitly assumed that they radiate like perfectly black bodies. Several investigators have pointed out that this assumption does not tally with experimental results. The temperature obtained by applying the total radiation law and the method of isochromatics to the spectral-energy curve are at variance with each other. They are also different from the temperatures obtained from the ionisation-theory.

The best example is afforded by the sun, which, according to the careful measurements of Abbot and Wilsing, shows a spectral-energy curve considerably deviating from that of a black body (see E. A. Milne, Phil. Trans. vol. 223, p. 218); the fact has been discussed by many investigators, including Schwarzschild, Groot, Milne, Dietzius, and others. There are very weighty reasons why the sun would not radiate like a black body. A black body or a full radiator is one which absorbs all the radiant energy which falls on it, reflecting none. Such an ideal body is nowhere met with in the world, but Wien and Lummer realised it by making use of a hollow enclosure maintained at a constant temperature, and provided with a small hole, the idea being that a beam of radiation within the enclosure would describe an infinitely circuitous path, and what the emission lacks in fullness will be made up by repeated reflections.

It is clear that none of these conditions is fulfilled in the case of the sun. The surface of the sun contains a large percentage of free electrons, and positive charges, which endow it with a large reflecting power. This point will be clear if we remember the analogous case of metals. According to the electromagnetic theory, metals derive their high reflecting power from the presence in them of a large number of free electrons, or rather electrons which are easily excited to vibration by incident radiation. A theory of emissivity of metals on this basis was worked out by Aschkinass in 1905, and has been verified by the experiments of Rubens and Hagen, Langmuir, and others.

The presence of a large percentage of free electrons on the surface of the sun would, thus, endow it with a high reflecting power. The surface being an open one, the hollow enclosure condition is not realised. Thus the conclusion seems to be irresistible that the total emission from the surface would fall far short of that of full radiator. The form of the spectral-energy curve suggests the emissivity E_λ varies as $\frac{A}{\lambda^{6+x}}\phi(\lambda\theta)$ where $1 > x > \frac{1}{2}$, but about this point judgment should be reserved now.

Turning to the stars, it is easy to see that similar conditions would hold. The analogy with metals enables us to say that the emission from low temperature stars would fall far short of that from a full radiator at the same temperature, while for stars with very high temperature, emissivity may approach that of a black body.

Prof. Eddington's work on the constitution of stars is based on the assumption that inside the stars total emissivity varies as T^4; this assumption is probably not affected, for, inside the stars, the hollow enclosure condition is largely fulfilled.

MEGH NAD SAHA.

University College of Science, Calcutta,
July 5.

Separation of Common Lead into Fractions of Different Density.

BY fractional crystallisation of lead assay foil, about 300 grams in all, two end fractions, each weighing about 60 grams, were obtained. These fractions were then purified according to Stas's method. For the density determinations, about ten grams of each was melted in an atmosphere of hydrogen and allowed to solidify in a vacuum. The densities of samples prepared in this way were determined in specific gravity bottles.

Density of lead from *crystals* end of fractionating series :—$11 \cdot 345 \pm 0 \cdot 005$.

Density of lead from *mother liquor* end of fractionating series :—$11 \cdot 313 \pm 0 \cdot 005$.

A sample of Stas lead, which Mr. C. T. Heycock very kindly gave me, was found to have the density 11·328 in one experiment and 11·326 after re-melting.

The difference in density between the above-mentioned fractions persisted after granulating the metal and also after re-melting the granulated metal under potassium cyanide. It was discovered in the course of these experiments that lead which has solidified slowly is not homogeneous as regards density,—the parts which freeze first being denser.

Out of eleven experiments, only one was inconsistent with the view that the original lead had been separated into two fractions which had different densities.

The work is being continued.

R. H. ATKINSON.

Goldsmiths' Metallurgical Laboratory,
University Chemical Laboratory,
Cambridge, July 18.

Proposed International Survey of the Sky.

ON the initiative of the French National Meteorological Service, it has been decided to take photographs of the clouds three times daily during the week September 17-23, inclusive, at as many stations as possible throughout the countries of western Europe. As the number of official meteorological stations is limited, it has been proposed to enlist the services of those professional and amateur photographers who are willing to co-operate voluntarily in the work. The photographs should be taken as nearly as possible at 7 A.M., 1 P.M., and 6 P.M. G.M.T. (not summer time). The photographer should make a note of the direction in which the camera is pointing when the photograph is taken (*e.g.* north, south-west, etc.); if more than one photograph is taken at any

hour it will be advantageous to take them in opposite directions (*e.g.* south-west and north-east). A reseau of five photographs would practically cover the whole visible sky when an average lens is employed, and it is accordingly recommended that, when possible, one photograph should be taken towards each of the points north, east, south, and west, and one towards the zenith. Photographers should be particularly careful to mark their plates in some way, so that the photographs in the different directions may be readily recognised after development; the inclusion of a small strip of horizon might be advisable for this purpose. In the case of the zenith photograph, a small part of some object might be included (*e.g.* the top of a tree or the corner of the roof of a house) to indicate the orientation of the plate.

The main object is not to secure artistic effects, but rather to obtain clearly defined records of the cloud forms present, and therefore "contrasty" results are preferable.

Photographers who are willing to take part voluntarily in this work are invited to send their names to one of us at Stoner Hill, Petersfield, and these volunteers will be supplied with the necessary instructions when these are ready for distribution. At the request of Col. Delcambre, of the French Meteorological Service, instructions for taking the photographs have been drawn up by one of us and are to be circulated internationally.

C. J. P. CAVE.
G. AUBOURNE CLARKE.

An Einstein Paradox: an Apology.

ALLOW me to express regret for having misinterpreted Prof. Einstein's symbols. My mistake was caused by the fixed idea that it was impossible for K_1 *in motion* to learn anything about the signal at L *until the light reached him.*

I owe to Mr. C. O. Bartrum the explanation that there are three events, namely, (1) the emission of light-signal at L; (2) its reception by K_1; (3) its reception by K; and that each requires its own double set of space-time co-ordinates; thus (x_1, t_1), (x_2, t_2), (x_3, t_3) in K's system and the same letters with accents for K_1's. There will then be three pairs of Einstein equations.

I find, however, from letters received, that opinions differ as to the interpretation of the t's. Some think that they are the actual times recorded by the clocks; others that they have to be corrected by allowances for the passage of light. Some think that a body in motion actually contracts and that a carried clock goes slow; others that the body only seems to contract and that each of the two observers thinks that the other's clock goes slow. The latter have a difficulty in explaining the constant c.

The simple problem of which the Newtonian solution was given in NATURE of June 2 ought to admit of a solution by relativity methods. I should be greatly obliged to any of your readers who would send me one showing the time on K's clock when the signal reaches K, viz. $x_1/v + x_1/c$.

R. W. GENESE.

40 London Road,
Southborough, Kent.

Colour Vision and Colour Vision Theories.

PROF. PEDDIE, in NATURE of August 4, p. 163, has dealt with some of my strictures of the trichromatic theory. Whilst nothing can be said against his mathematical presentation of the theory, it can easily be shown that, when a case of colour blindness is fully and carefully examined, the mathematical presentation will not account for the facts. All the facts which are explained by the trichromatic theory are, however, consistent with my theory.

The trichromatic theory becomes more and more complicated with subsidiary hypotheses, inconsistent with each other. I have examined a man stated to be completely red blind, but tested with my lantern he recognised red as easily as a normal-sighted person. How do 50 per cent. of the dangerously colour blind get through the wool test? The trichromatic theory completely fails to explain the trichromic class of the colour blind. The trichromic have no yellow sensation, regarding this region of the spectrum as red-green and marking out in the spectrum a monochromatic division including yellow, orange-yellow, and yellow-green.

If the trichromatic theory were true the point where the hypothetical curves cut should be shifted towards the defective sensation; this is not found. Let the trichrome now be examined by colour-mixing methods, and he may make an equation $R+G+V=W$, with too much red in the mixed light, and then make an equation with too much green in the mixed light. Again, he may agree with the normal match, or in other cases only agree with the normal match when the comparison white light is diminished in one case or increased in another, thus matching two white lights of different luminosities.

F. W. EDRIDGE-GREEN.

London, August 7.

Stirling's Theorem.

THE recent correspondence in the columns of NATURE on this subject prompts me to add to the collection a formula which I deduced about three years ago. It was then communicated to a mathematical friend, but has not otherwise been published.

The ordinary Euler-Maclaurin series for $\log_e n!$ is

$$\log\sqrt{2\pi} + (n+\tfrac{1}{2})\log n - n + 1/12n - 1/360n^3 + 1/1260n^5 \ldots$$

It is easily shown that the last three terms printed above are reproduced exactly by the first three terms of the binomial

$$\frac{1}{12n}\left(1+\frac{113}{210n^2}\right)^{-7/113};$$

while the simpler binomial

$$\frac{1}{12n}\left(1+\frac{8}{15n^2}\right)^{-1/16}, \text{ or } \frac{1}{12n}\left(\frac{15n^2}{15n^2+8}\right)^{1/16},$$

reproduces exactly the terms in $1/n$ and $1/n^3$ and very approximately the term in $1/n^5$. Adopting the simpler form, we have

$$\log n! \doteqdot \log\sqrt{2\pi} + (n+\tfrac{1}{2})\log n - n + \frac{1}{12n}\left(\frac{15n^2}{15n^2+8}\right)^{1/16},$$

or passing to common logs ($M =$ modulus),

$$\log_{10} n! \doteqdot 0{\cdot}39908993 \ldots + (n+\tfrac{1}{2})\log_{10} n - nM + \frac{M}{12n}\left(\frac{15n^2}{15n^2+8}\right)^{1/16}.$$

This formula gives for 1! (true value 1), 1·00007 . . .; for 2! (true value 2), 2·000002 . . .; for 3! and 5! no discrepancy is shown by 7-figure logs and 9-figure logs respectively. The degree of approximation is therefore high and even remarkable; but it may be doubted whether this formula or any of those under discussion is really to be preferred to the direct use of the series of which we can easily take as many terms as may be required for the order of accuracy desired.

G. J. LIDSTONE.

9 St. Andrew Square, Edinburgh,
July 24.

The Growth of the Telescope.[1]

By Dr. WILLIAM J. S. LOCKYER.

IN the beginning of the year 1608, that is, 315 years ago, or about ten generations, telescopes did not exist. The main work of astronomers before the year 1608 was, therefore, concentrated upon observing and recording the positions of the heavenly bodies from day to day and from year to year. The early (1587) instruments for observations of position took the form of graduated quadrants mounted in a vertical plane capable of rotation about the centre of a horizontal divided circle. The direction of a heavenly body could be indicated only by pointing at it; so every quadrant was furnished with a pointer pivoted at the centre of the quadrant. The adjustments of the instruments were made by using a plumb line for the determination of the vertical, and a level for placing the azimuth circle horizontal.

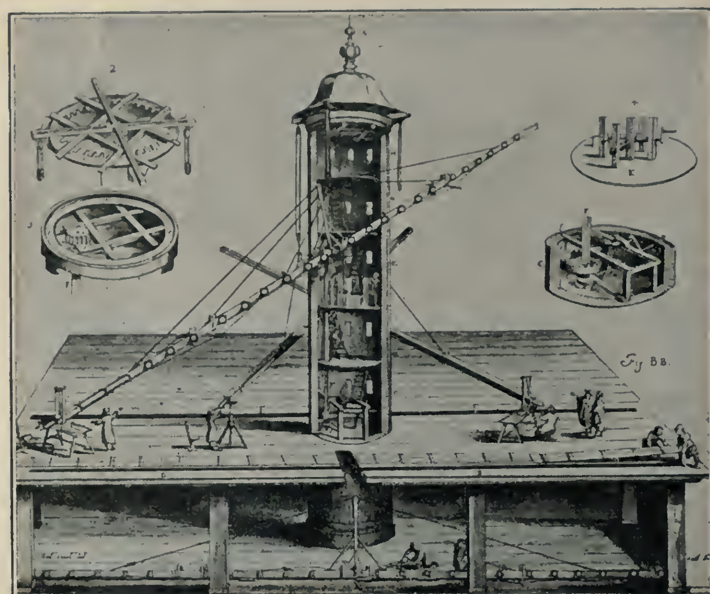

FIG. 1.—Hevelius's aerial telescopes mounted by suspension from the roof of a tower which can be rotated by gearing.

Tycho Brahe, the famous Danish astronomer (1546–1601), constructed many elaborate instruments of this nature for his observatory at Uraniberg, but his most important instrument was the large quadrant fixed in the meridian with which he observed transits of the heavenly bodies through a hole in the south wall. This instrument was the forerunner of the modern transit circle.

Galileo was the first to use the "optik tube" for the study of the heavenly bodies, and in consequence made a series of important discoveries. Thus, he found that the number of stars was enormously increased; the "wandering stars" were really planets; the moon displayed mountains; Jupiter possessed a family of satellites; Saturn exhibited curious features which were eventually identified as a ring system; Venus appeared as a crescent; spots were visible on the solar surface, etc. The lens combination employed by Galileo underwent changes as time advanced. In 1620 Kepler suggested the use of two double convex lenses, and this was actually carried out by Scheiner in 1637. Astronomers had to wait nearly 100 years before Chester More Hall, in 1733, put forward the idea of making an object-glass of two different kinds of glass—crown and flint—placed close together, thus establishing the so-called achromatic lens. It was not, however, until another quarter of a century had passed that John Dollond in 1758 rendered this discovery effective, thus heralding the dawn of what may be termed modern astronomical observation.

In the year 1639 the discovery of another form of telescope was made, namely, the reflecting telescope; but it was not until the year 1663 that the principle was described in practical form by James Gregory. It was left, however, to Sir Isaac Newton in 1668 actually to construct an instrument of this nature, and the telescope he made, which is quite small, is to-day in the rooms of the Royal Society of London. Like the refracting telescope, the reflecting telescope underwent various changes in the optical train; thus we have the forms now known as the Newtonian, Gregorian, Cassegrainian, and Herschelian.

As soon as the refracting telescope became a practical instrument it was at once brought into commission for instruments employed in the measurements of the positions of the heavenly bodies. In fact, it at once replaced "pointers." Tycho Brahe's great quadrant was soon superseded by a type of instrument similar to that made in 1770 by Sisson for the Kew Observatory. This was an 8-foot quadrant, mounted in the meridian, with a finely divided scale and vernier. The quadrant form developed later into a complete graduated circle read by several microscopes after the type of Gambey's mural circle, made in 1819 for the Paris Observatory.

The acme of perfection in accuracy is reached to-day by such an instrument as the present Cape Observatory transit circle. In this the telescope has an objective of 6 inches aperture of the finest construction, two very finely graduated circles are attached, and several micrometers are employed for reading each circle. Many other refinements, too numerous to mention here, are included to attain the highest accuracy.

In order to follow the developments of the two kinds of telescopes, namely the refractors and reflectors, it is best to deal with each kind separately. Returning to the epoch many years before John Dollond made the achromatic lens effective, it was found that an object glass, which then consisted of a single lens only, formed images at the focus which were highly coloured and spoilt definition. The only method of securing greater magnifying power, with increase of aperture or diameter of lens, was to make the lenses of great

[1] From a discourse delivered at the Royal Institution on Friday evening, April 20.

focal length; for experience had shown that the greater the focal length the less the colour.

Thus, about the year 1680 we come to the age of giant telescopes, when their lengths measured anything from 60 feet to 210 feet. These cumbrous instruments were generally suspended by their middle from tall masts or towers, and to reduce their weight diaphragms placed at stated intervals took the place of wooden tubes. Thus were the telescopes of Hevelius. Huyghens adopted the novel principle of only placing the object glass on the mast, the eyepiece being attached to it by a long cord which could be stretched tight, and so make the proper optical alignment.

An illustration of a giant observatory of Hevelius's time given here (Fig. 1) displays three of these long telescopes in use. Mechanism is shown by which not only can the telescopes be hoisted into position but the roof of the tower to which the telescopes are suspended can also be turned round to neutralise the earth's motion. The illustration shows that even in those days a considerable observatory staff was necessary.

A telescope cannot be properly manipulated unless it is equatorially mounted, *i.e.* mounted on an axis inclined to the latitude in which it is used. One of the first, if not the first, telescope to be set up in this manner was that used by Scheiner in 1618 for observing the spots on the sun. Scheiner had only to direct the telescope to the sun, and fix it in declination, when the diurnal movement could be compensated by simply moving the telescope westward by hand. The form of mounting he adopted was the foundation of the German type of mounting telescopes, to which reference will be made later.

Not only is it imperative for a telescope to be equatorially mounted, but it must also be driven by some power, clockwork or otherwise, so that the object under observation will always remain in the centre of the field of view of the telescope. Hooke, so far as is known, was the first to adopt this principle in 1674. As is indicated in an old print of his instrument, he mounted his quadrant at the upper end of a long polar axis, and rotated this by means of gear wheels actuated by a falling weight. The speed was controlled by a conical pendulum governor, which could be shortened or lengthened at will. We had to wait, however, until the year 1823 before a really efficient driving clock was applied to a telescope. This was the work of Fraunhofer, and was adapted to the 9½-in. Dorpat refractor, the largest refractor of that period, made for the Czar Nicholas of Russia. The principle is the same as that used to-day; the clockwork, driven by weights and controlled by a governor, actuating a tangent screw which is in gear with the threads cut in the circumference of the driving circle to which the telescope can be clamped. The Dorpat instrument may be said to be the first real modern refractor, as it embodied all the fundamental features of telescopes constructed afterwards.

There are three well-known recognised forms of mounting telescopes, illustrated in Fig. 2, and termed the "English," "German," and "Composite" types. In the English type the telescope tube is mounted directly on the polar axis midway between the supports of this axis, and being symmetrically placed balances itself both in Right Ascension and Declination. The composite type is rather similar to that of the English,

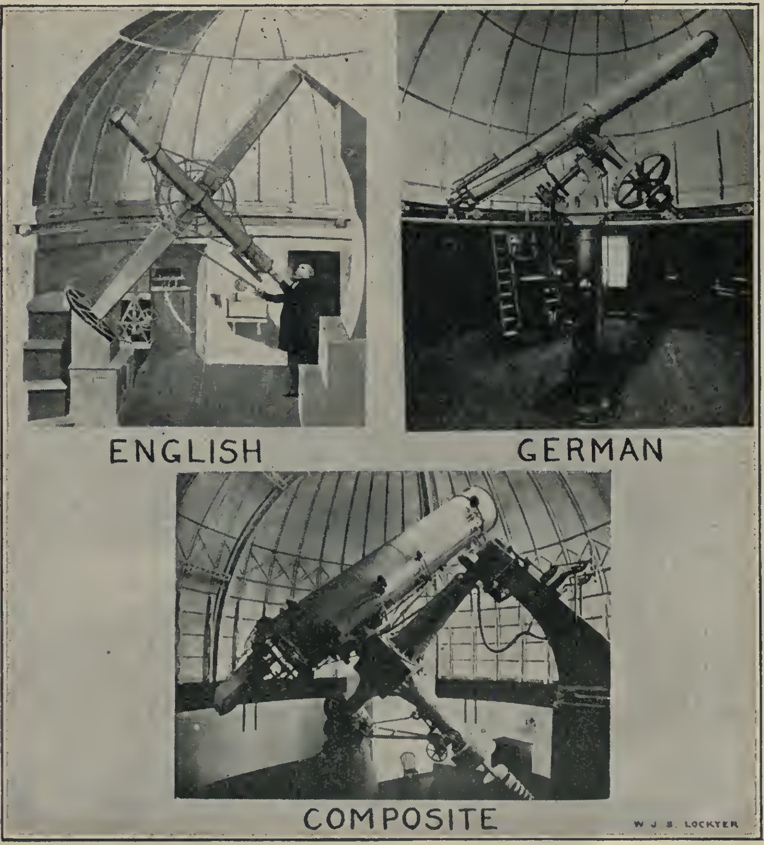

Fig. 2.—The three main methods of mounting telescopes.

only the tube is placed on one side of the polar axis and the counterpoise weights on the opposite side. In the German type, the tube with its counterpoise weights is fixed symmetrically to the prolongation of the upper end of the polar axis, that is, outside the supports of this axis. There is still a more modern modification of the German type, in which the polar axis is prolonged at its upper end, taking the shape of a fork. The telescope tube is placed symmetrically in this fork, thus obviating the necessity for counterpoise weights.

Coming now to the advance in telescope construction, mention only may be made of such instruments as the 15-inch Pulkowa (1839) by Merz and Mahler, the 15-inch Harvard (1847), also by Merz and Mahler, and the 18-inch Chicago University telescope (1862), by Alvan Clark.

The year 1868 saw the completion of the fine 25-inch

made by Cooke for Mr. R. S. Newall's observatory at Gateshead. This instrument, by far the largest of its day, was mounted after the German form. It had a focal length of 30 feet, so that the dome and observing chair had to be of great proportions. So satisfactory was the behaviour of this instrument, that, after a journey to this country to inspect this telescope, the representatives from the Washington Observatory ordered a 26-inch of 32-feet focal length from Alvan Clark, and it was completed in 1873.

In 1880, Grubb surpassed this size by making a 27-inch for the Vienna Observatory; but five years later (1885) Alvan Clark turned out a 30-inch objective of 42-feet focal length for the Pulkowa Observatory. The following year (1886) saw another objective of the same size constructed by the Brothers Henry for the Nice Observatory, but this was soon eclipsed by the completion in 1887, by Alvan Clark, of the Great Lick Refractor of 36-inch aperture and 57-feet focal length, erected on Mount Hamilton, in California. For this instrument an observing chair, as such, had to be abandoned, but the floor of the observatory was made capable of elevation and depression, thus avoiding many difficulties and adding great facilities.

Two large telescopes, though not records in size, followed the construction of the Lick instrument. The first was the 28-inch of 28 feet focal length by Grubb (1893) for the Greenwich Observatory, mounted after the English fashion; this is the largest refractor in Great Britain to-day. In the following year (1894) the Brothers Henry completed the 32-inch, 53 feet focal length telescope for the Astrophysical Observatory at Meudon, near Paris.

The largest refractor in the world to-day, namely the Yerkes telescope of the University of Chicago, was completed in 1895, the object glass by Alvan Clark being 40-inch in diameter and of 62-feet focal length. It is mounted very similarly to the Lick instrument and fitted with all the latest facilities for assisting the observer at the eye end, including a rising and falling floor.

In mounting large refractors the standard forms have occasionally been departed from in order to attain some special end. Four examples of these may be mentioned here. Thus at the Paris Observatory there was erected in 1890 a 23½-inch objective of 62-feet focal length in a tube mounted in the "Coudé" form after the design of Monsieur Loewy. This instrument is so constructed that the observer is housed in a comfortable room in which the eye end of the telescope is suitably fixed, and he can observe any object in the heavens, without moving from his chair, by means of reflections from two mirrors in the peculiar shaped tube after the light has passed through the object glass.

Another novel form was exhibited at the Paris Exhibition of 1900 to utilise an object glass of 49 inches aperture and 197 feet focal length made by Monsieur Gautier. In order to avoid the necessity of having to move such a heavy object-glass and tube, the principle adopted was to place the telescope horizontally in a true north and south position with the object-glass facing north. The light from any celestial object was then reflected into this tube by means of a large silver-on-glass mirror mounted as a siderostat and moved by clockwork. This particular telescope has never been effectively used, so in spite of its great objective it has not been classed as the greatest telescope of to-day.

A curious mounting is that employed for the 27-inch telescope of 70 feet focal length of the Treptow Observatory, near Berlin, erected in 1909. The main object in the construction was to obviate the cost of a large dome and rising floor, and also to make the eye-piece of the instrument very easy of access for numerous visitors. To accomplish this, the tube was erected on the modified German type of mounting in such a way that the eye end of the tube should be situated just above the upper end of the polar axis. The tube was counterpoised in declination by two great weights placed at the extremities of two long arms extending northwards and symmetrically placed as regards the tube. Thus the eyepiece was in the centre of motion of the telescope and practically stationary for all positions of the tube: also by simply setting the tube near the position of horizontality it could be covered by a light wooden low structure.

The last novel form of mounting to be mentioned was erected in 1912, and is known as the 150-foot Tower Telescope of the Mount Wilson Observatory. Its origin developed from the fact that an objective of long focal length was required to be used in conjunction with a spectroscope also of long focal length.

Previous experience had shown that air currents near the ground affected the definition when such long instruments were used in a horizontal position. Dr. G. E. Hale conceived the idea of mounting the object lens high up on a metal girder tower and throwing the images of the celestial object to be studied vertically downwards on to the spectroscope placed vertically in a shaft in the ground, employing two plane mirrors above the object-glass to reflect the object downwards. The actual lens in use has an aperture of 12 inches and a focal length of 150 feet, while the focal length of the spectroscope is 75 feet. One of the chief peculiarities of the construction was that the girder work of the Tower was really in duplicate, one within the other and not touching at any place. While the dome at the top rested on the outer casing, the mirrors and lens were supported by the inner one; thus any wind pressure which might set up vibration in the outer casing did not affect the inner casing which supported the optical parts of the arrangement.

Reference has previously been made to the various forms of reflecting telescopes, such as the Newtonian, Gregorian, Cassegrainian, and Herschelian, and to the first reflector ever made, namely, that by Sir Isaac Newton in 1668. For a long time the progress of this type of telescope was slow, but impetus was given to it by Sir William Herschel, who was the first to make mirrors of really large dimensions. The mirrors themselves were composed of speculum metal—an alloy of copper and tin and highly polished. Herschel's largest reflector was four feet in diameter, with a focal length of forty feet. It was erected at Slough, near Windsor, in the year 1789. The tube was pivoted near the ground and mounted between high wooden trestles: while there was no restriction to its movement in the vertical direction it was only capable of a very small lateral motion east and west of the meridian. Just as Galileo, with his pigmy refractor, revolutionised ideas with his wonderful discoveries, so Herschel with the

giant reflector of his own construction made momentous additions to our astronomical knowledge.

Nearly sixty years later (1845) Lord Rosse ground, polished, and mounted a six-foot reflector at Parsonstown in Ireland. This leviathan of 54 feet focal length was mounted somewhat after the fashion of Herschel's, but solid masonry replaced the wooden-trestle structure. The movements of the tube were also similarly restricted.

While Lassel's reflectors, the largest of which was four foot and made in 1863, were not an advance in size, yet he instituted a great improvement by mounting the instrument equatorially after the modified German type. Grubb in 1870 completed a mirror of the same dimensions for the Melbourne Observatory, mounting it in the composite fashion. This was the last large reflector which employed a mirror of speculum metal, because glass mirrors were beginning to supersede them.

In the years 1856 and 1857 Steinheil and Foucault discovered a method of making mirrors by depositing silver on glass surfaces. This produced a highly efficient reflecting surface and soon came into common use. One of the first large reflectors with this type of mirror was that made by Foucault himself for the Paris Observatory. It was constructed on the Newtonian principle, mounted equatorially on a heavy wooden framework movable on castors and clock driven. In 1875 Martin made a four-foot mirror for the same observatory, and it was only owing to the thinness of the glass disc in relation to its diameter that it was not a success. The completed instrument was mounted in the composite form.

An immense advance was made by Common, who in 1888 constructed and used a mirror of five feet diameter. The tube was mounted on the modified German plan, being placed in a fork bolted to the upper end of the polar axis. To minimise the great weight of the polar axis on its bearings the novel idea of floating it was adopted. It was not till the year 1908, that is, twenty years later, that a mirror of the same size was made. This was accomplished by Ritchey for the Mount Wilson Observatory: the style of mounting was rather similar to that adopted by Common.

Another ten years saw the completion (1918) of the six-foot reflector for the Dominion Observatory, Ottawa. This great glass, the work of Brashear, is equal in size to the speculum mirror of Lord Rosse and weighs two tons. The form of mounting of the tube is after the composite type, the moving parts weighing 35 tons. The telescope is capable of being used either as a Newtonian or as a Cassegrainian.

It should be noted that "rising floors" in an observatory cannot be employed for reflecting telescopes of the Newtonian form because the eye end of the telescope is situated at the upper end of the tube. The staging to accommodate the observer is therefore of very complex construction, and the arrangements adopted vary very considerably from one instrument to another, no two forms being alike.

We come now to the largest reflector of the present time, namely the Hooker 100-inch erected at the Mount Wilson Observatory in 1919. This mirror of 13 inches thickness, and weighing four and one-half tons, has a focal length of 42 feet. Though the block of glass was cast in France, the figuring and silvering is due to the skill of Ritchey. The great tube carrying the mirror is mounted after the English type, and the moving parts of the telescope amount in all to fourteen and one-half tons. Either the Newtonian or Cassegrainian form of instrument can be utilised. Thus, after a lapse of two and a half centuries, the one-inch reflecting telescope of Sir Isaac Newton has grown into a monster of 100 inches.

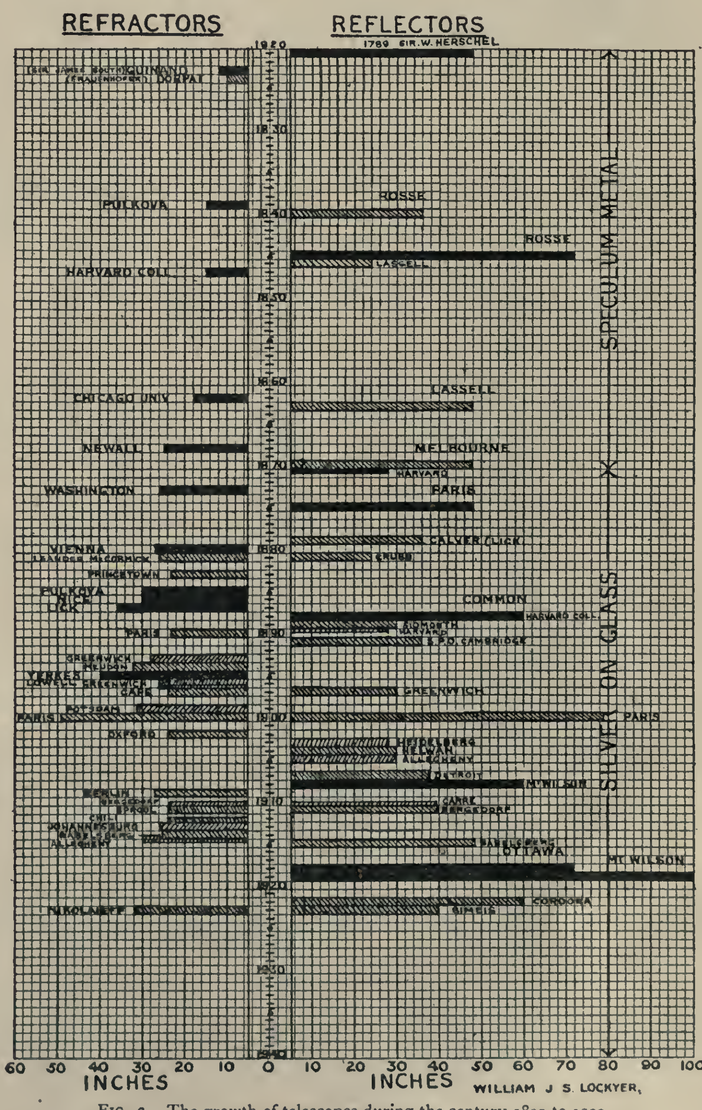

FIG. 3.—The growth of telescopes during the century 1820 to 1920.

Having thus separately surveyed the progress of the two types of telescopes, it is interesting to obtain a bird's-eye view of this growth. This is represented by

means of the accompanying diagram (Fig. 3). The period of time covered is the century beginning in 1820, and while the years are displayed down the centre of the diagram, the size (in inches) of the object glasses and mirrors are shown respectively on the left- and right-hand sides against the years of their erection. Many other large instruments of interest, apart from those that were records in size in their time, have been inserted.

No less interesting and important is the study of the geographical distribution of large telescopes. For this purpose the positions of the great telescopes have been indicated on a chart of the world (Fig. 4). On this diagram refractors from 30 to 40 inches aperture are represented by large black spots, and those between 20 and 29 inches by small black dots. On the other hand, reflectors from 60 to 100 inches in diameter are indicated by large circles, and those from 30 to 59 inches by small circles. It will be seen that the very large telescopes predominate in two main regions, namely Europe and the United States of America with Canada. Only one telescope of the very large type is situated in the southern hemisphere, and that is the five-foot reflector for the Argentine National Observatory at Cordoba. This instrument, although completed, has not yet been erected.

South Africa and Australia are both blank in this respect, except that a 26-inch refractor is nearing completion for the former, but it is hoped that in the near future both these countries will be better represented.

The limit of size of a telescope, whether it be refractor or reflector, for the accomplishment of useful work has by no means yet been reached, providing the instrument be placed in a specially selected locality high up on some extensive plateau, where the "seeing" is of a high-class nature during the greater part of the year.

This limit is at present only temporarily restricted by the maximum limit that can be reached by those whose work it is to cast the necessary glass blocks. The mounting of even the largest telescope is now only a mild engineering problem.

It must not be forgotten, however, that large telescopes are very expensive not only to construct but also to house; yet experience has shown, at any rate in the United States of America, that when occasion arises an enthusiastic private donor generally appears.

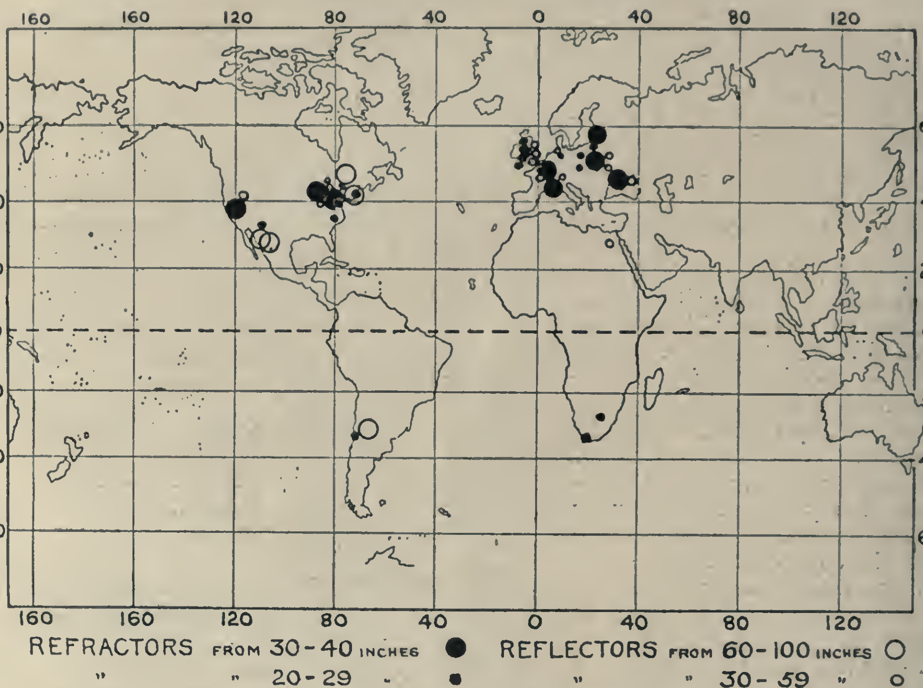

FIG. 4.—Geographical distribution of large telescopes.

Obituary.

THE death is announced of Dr. Hermann Biggs, Commissioner of Health, New York State, at the age of sixty-three. After graduating at Bellevue Medical College, Dr. Biggs studied in Berlin and Greifswald, and returning to the United States in 1895, directed the production of the first diphtheria antitoxin in that country. In 1900 he became general medical officer of the New York City health department, and there established the first municipal bacteriological laboratory. This post he held until 1914, when he was appointed Commissioner of Health to New York State. Under his administration the health of New York City and State changed markedly for the better. He organised a campaign against tuberculosis, and was responsible for a body of wise health legislation. He was a scientific director of the Rockefeller Institute, and, for a short time, medical director of the League of Red Cross Societies. He gave to his country and to the world distinguished services, and preventive medicine loses by his death an ardent disciple. R. T. H.

Current Topics and Events.

Atomic projectiles have been used by many investigators to batter down the defences which have guarded so well the innermost mysteries of the structure of matter. The α-particle, liberated spontaneously in radioactive transformations, has, thanks to its enormous velocity, been of special service in elucidating the constitution of the atom. In these investigations no one has played a more important part than Sir Ernest Rutherford, and it is, therefore, appropriate that in the address which appears as a supplement to this issue of Nature he should give an account of the life history of such a high-speed α-particle. When the particle is expelled from a radioactive substance, it has been proved to be the nucleus of a helium atom of mass 4 carrying two positive charges of electricity. Recent experiments by Henderson have shown how, by the successive capture of electrons, the α-particle becomes a neutral helium atom. The experiments, which were carried out by observing the deflexion of a narrow pencil of α-rays in a magnetic field, have been confirmed and extended by Sir Ernest Rutherford. It appears that not only may the doubly charged helium nucleus remove and capture an electron from the outer electron structure of the atoms in its path, but the converse change may also take place. In passing through other atoms this electron may be knocked off, and the singly charged α-particle revert back to the doubly charged type. The somewhat unexpected conclusion is reached that this process of capture and loss may repeat itself more than a thousand times in the flight of the particle. Similar considerations apply in the case of singly charged and neutral helium particles. Though the results of these encounters may be less startling than those in which disintegration of an atomic nucleus like that of nitrogen or of aluminium occurs, it seems probable that the study of these rapid interchanges of charge will yield information of great value to the theoretical physicist.

The attempt to restrict the spread of epidemic disease amongst plants is creating a phytopathological service of inspection in many countries, and legislation is gradually restricting the free movements of plants and plant produce in and out of the various countries. In a paper under the title "The Biological Basis of Plant Quarantines" contributed to *Phytopathology* for June, W. A. Orton and R. Kent Beattie attempt to get down to the first principles underlying such legislation, and their views deserve careful study in Great Britain, both by growers and students of pathology, as, if the conclusions arrived at find favour in the United States, the British exporter of plants may experience increasing difficulties in the way of export trade with that country. The authors draw a fundamental distinction between communications between countries that are close neighbours, and traffic in plants across the ocean barriers that separate continents. They conclude that within the area of a continent the cultivated host plants and their parasites will in most cases have fought out their battle and arrived at an approximate equilibrium, the issue of the conflict varying of course each season, but without violent fluctuation. When, however, a parasite crosses an ocean barrier, then its arrival in the new continent may be followed by incalculable results, and a cultivated crop may almost be exterminated before selection of more resistant forms, or other factors operating over a space of time, have again produced an equilibrium in which the cultivation of the crop is economically possible, allowing for the average loss produced by this parasite. These results may follow, even when the parasite thus introduced is one regarded as relatively innocuous in the continent where it has long been known. For example, chestnut bark disease, *Endothia parasitica*, though a relatively minor trouble in Asia, has, since its introduction to America, bid fair to destroy all the chestnut forests of the country. The author's arguments bring them into disagreement with the conclusion of the last International Phytopathological Convention, held in Rome in 1914, as they emphasise the importance of "common species of long-standing dispersion" which inspecting officials naturally tend to overlook, and lead them to the very important general principle that "inter-continental trade in plant propagating material is fundamentally dangerous, and to be held within the narrowest limits compatible with economic need."

One of the best-known German scientific workers, and at the same time one of the founders of modern physical chemistry, Wilhelm Ostwald, who was born September 2, 1853, at Riga, is about to celebrate his seventieth birthday. After having studied at Dorpat he was appointed, in 1883, professor of chemistry at the Baltic Polytechnical School of Riga, and, in 1887, professor of physical chemistry in Leipzig. Here he developed a great ability as an investigator as well as a teacher. His work gave a firm experimental foundation to the theories of van 't Hoff and Sv. Arrhenius. There, scientific workers from all over the world assembled round the master, and built up, in a short time, the edifice of modern physical chemistry. Besides this work, Ostwald produced a number of valuable text-books, including his large "Outlines of General Chemistry," "The Fundamental Principles of Chemistry," "The Principles of Inorganic Chemistry," and "Scientific Foundations of Analytical Chemistry." At the end of last century Ostwald devoted himself more to questions of natural philosophy, such as the energy resources of the world. These studies, the fight against scientific materialism, and the propagation of Haeckel's monistic philosophy so occupied his mind that he gave up his professorial duties in 1906 and retired to his country seat in Grossbothen, Saxony. It was a token of the breadth and productivity of Ostwald's mind that even then he created for himself quite a new sphere of activity. Starting from the art of painting, which he had loved and cultivated since his youth, he worked out a new system of colour, by which every tint can be

characterised by exact figures. He has expounded the system in various works on colours, and it has already led to the foundation of an institute for colour investigation in Dresden. The numerous pupils and friends of Ostwald rejoice in the work of their leader and offer him their tribute of esteem.

THE second triennial Pan-Pacific Science Congress, which opened at Melbourne on August 13, is being held under the auspices of the Australian National Research Council and with the support of the Commonwealth and State Governments. The first congress was held in Honolulu in 1920, and the third will be held in some other country bordering on the Pacific. The object of these congresses is the promotion of the study of scientific problems of common interest, and the meetings form part of a general plan aiming at the maintenance of harmonious relations between all the countries within and bordering the Pacific region. In addition, therefore, to representatives from Great Britain and various parts of the Empire, distinguished men of science from the United States, Japan, and Formosa, the Netherlands, Dutch East Indies, and other countries are attending the Melbourne congress. Among the subjects under discussion are: irrigation problems; agricultural education and research; genetics, with special reference to the improvement of farm animals; organisation of research among the natives of the islands of the Pacific. (A strong effort will be made to obtain from ethnologists agreement as to a definite and practical scheme for the investigation at once of the fast-disappearing races in those islands in which Australia is especially interested. If such a scheme can be devised it will be laid before the Commonwealth Government with an urgent plea that it be put into effect at once); introduced pests and natural enemies; paper pulp: Australian possibilities; meteorology of the Pacific; terrestrial magnetism in Pacific regions; value of hydrographical work of the Royal Navy, and Australia's responsibility to continue it; survey of the Great Barrier Reef; international notification of animal diseases; hygiene of Pacific Region; fisheries and marine biological stations; parasitological problems, etc. We hope to give an account of the proceedings of the congress in a future issue.

A SPECIAL number of the *Revue Scientifique* was published on July 28, under the title of "L'Œuvre de Pasteur et ses conséquences." We may regard it as the complement of the special Pasteur number of NATURE: but it goes further afield. It contains many articles by writers of great authority: and it represents the devotion of all France to Pasteur's memory. He lived and worked for France, and wore out his life for her. His work was for the good of the world. Still, it was for the honour and glory of France: that was his revenge, after 1870, to set France high above Germany in a vast domain of science. Every year we in Great Britain, though we are grateful to him, are living under this disgrace, that we have no monument or memorial to him, to show our sense of gratitude for all that we have learned from him. Among the articles in this number of the *Revue Scientifique* are two of remarkable interest. One is on the predestined course of his discoveries, "L'Enchaînement des découvertes de Pasteur." There is no end to the wonder of this orderly and inevitable enchainment of discoveries. The other article is "Pasteur et la Maternité." It tells the story of Semmelweis and his defeat: and the story of Tarnier's work, who in one year saw, in the Maternité de Paris, 132 women, out of 2237, die of puerperal fever: indeed, in May, out of 31 admitted for confinement, 30 went out dead. Then, the wearisome debating and theorising, up to that day in 1879, March 11, in the Académie de Médecine, when Hervieux poked fun at the notion that puerperal fever was caused by germs, and Pasteur went up to the blackboard and sketched *streptococcus* on it, saying, "Tenez, voici sa figure." We see, by an advertisement in the *Revue Scientifique*, that copies of Aronson's bust of Pasteur can be had at prices according to size. Surely, some English shops ought to stock this bust. But where is our proper memorial of Pasteur in London?

A SEVERE typhoon was experienced at Hong-kong on Saturday, August 18, and much damage occurred, accompanied with loss of life. The wind is said to have attained a velocity of 130 miles an hour, which is stated to be the highest on record, and the barometer fell to 28·66 in., said to be the lowest reading on record at Hong-kong. In two hours, from 9 to 11 A.M., during the height of the storm the rainfall amounted to about 5 inches. Good notice was given of the approach of the typhoon, which was first reported on August 11, from Guahan, Ladrone Islands, in the North Pacific. The progress of the typhoon was about 270 miles a day to the west-north-west. Later reports fortunately state that Hong-kong has suffered far less than might have been expected, but the typhoon warning was again hoisted on August 20. Typhoons are regularly warned at Hong-kong by those in charge at the Royal Observatory.

IN the *General Electric Review* of America for August there is a complete technical description of the latest broadcasting station in New York. It is termed "Broadcast Central" and operates under the call letters WJY and WJZ. It was opened on May 15 and can be heard by radio listeners on the eastern side of the United States. It has "two channel" operation, so that it transmits two different programmes simultaneously. WJY, called the "jazz" channel, operates on a wave-length of 405 metres and broadcasts popular music, news, lectures, etc. The WJZ channel operates on a wave-length of 455 metres and broadcasts operatic and classical music. Both the studios are on the sixth floor of the Æolian Hall, which is in the centre of New York City. As concerts and recitals are always being given in this hall, arrangements have been made to broadcast them. Special line wires also have been run to the more important theatres and hotels, so that outside performances can be readily transmitted. The antennæ are strung from two 120-foot towers located on the roof at a distance of 175 feet apart and form two

separate four wire horizontal systems separated by ropes and insulators. The length of the wires forming one system is 45 feet, and the length of the other system is 55 feet. As the output of a high-quality microphone seldom exceeds a few millivolts, considerable amplification is necessary. A three-unit motor generator set is used. One of the generators has a 1000-volt commutator at each end, thus giving 1000 volts for the amplifier plate filter and 2000 volts for the transmitter. The equipment is all duplicated, one set being in reserve, so as to reduce the risk of a breakdown to a minimum. From the listener's point of view, this alternative choice of programmes is an attraction, and the operation of Broadcast Central has been extremely successful.

THE *New Phytologist* (vol. 22, No. 3) contains a very stimulating article by Dr. F. E. Clements under the title of "The Ecological Method in Teaching Botany," in which the author's ecological outlook is applied to the problems of teaching with the insistence upon quantitative study of environment, and the response thereto, that has proved so fruitful in his studies of vegetation. This paper should do good if only for its challenge to the traditional methods which hold such unquestioned sway, though many teachers will feel Dr. Clements's ideals—that the student's education should be based mainly upon first-hand investigation, brought into an ordered and correlated form by the method of group discussion, all the work being done "where the plants are, whether this be the greenhouse, garden, field or (much less satisfactory) the ordinary laboratory"—make demands which the staffing and accommodation of most British departments of botany would render impossible. Dr. Clements's distrust of the efficacy of lectures, his challenge to the professors' insistence upon principles as apart from facts, his criticism that the laboratory notebook, save for its indifferent quality, is more suitable to a drawing class, and his objection to the content of the typical elementary class in which morphology is paramount, are points in his paper which might well provoke animated discussion; but there can be little question that a new generation will do well to take a critical survey of the methods and results of the formal lecture and laboratory courses of their predecessors.

APPLICATIONS are invited by the Admiralty for a Junior Scientific Assistant in the Experimental department of the Signal School, the duties being concerned with the application of W/T devices; also for a Junior Scientific Assistant having a good knowledge of general physics, possessing an honours degree in physics or its equivalent, and with some experience in research. Applications for the posts should be sent to the Secretary of the Admiralty (C.E.), Admiralty, S.W.1.

REFERRING to the letter of Dr. G. D. Hale Carpenter on a waterspout with a sheath or sleeve, published in NATURE of September 23, 1922, p. 414, and one on the same subject by Dr. Willard J. Fisher in the issue of November 18, p. 669, Dr. Fisher writes to say that the same sort of sleeved tornado pendant seems to be described by R. Abercromby, in the Quart. Jour. Roy. Met. Soc., 16, pp. 119-126, 1890, as having been observed by Mr. S. Elson, a Calcutta pilot. Possibly the phenomenon is not very uncommon.

THE British Research Association for the Woollen and Worsted Industries announces the following awards for the year 1923–24: Research Fellowships: Mr. Robert Burgess, of Nottingham, to carry out investigations on the damage and deterioration caused by bacteria and fungi on woollen goods and yarns during storage; and Mr. H. E. Farrar, of Leeds, to conduct research on the dyeing of wool with acid and mordant colours. Advanced Scholarships: Mr. S. Menzer, tenable at the University of Leeds; Mr. T. N. T. Graham, tenable at the Scottish Woollen Technical College, Galashiels; Mr. P. M. Redman, of Keighley, and Mr. W. Lee, of Halifax, tenable at the Bradford Technical College.

WE have received from British Drug Houses, Ltd. (16-30 Graham Street, N.1), a specimen of their standard lactose B.D.H., which has been prepared of guaranteed purity for the particular requirements of bacteriologists and biologists. We have tested it with several strains of *Bacillus typhosus*, *B. paratyphosus*, *B. dysenteriæ*, and other micro-organisms, and find that it gives the characteristic and typical fermentation reactions of the respective organisms. One gram incinerated on platinum gave no weighable amount of ash. We therefore believe that the claim made as to the purity of this lactose is substantiated. It is supplied in 1 lb. sealed tins, price 3*s*. 6*d*. each.

THE Nouvelle Société Helvétique, 28 Red Lion Square, London, W.C.1, has just issued a useful bibliography of books dealing with Switzerland which have appeared in English since 1880. The list includes not only guide-books and tourist literature but also those on historical, constitutional, and social subjects, and in addition works by Swiss writers translated into English, as well as books in English on such pioneers as Rousseau and Pestalozzi in education and de Saussure in science. All lovers of Switzerland and its people will find the bibliography helpful and interesting. Copies may be obtained upon application to Dr. Paul Lang, Secretary of the Society, at the above address.

THE names of the green pheasant, the copper pheasant, and the golden pheasant were added to the Schedule to the Importation of Plumage (Prohibition) Act, 1921, by virtue of the Importation of Plumage (No. 2) Order, 1922, dated June 12, 1922. As was announced in the Press at the time, the Advisory Committee appointed under the Act, in recommending the addition of the names of these birds to the Schedule, further recommended that the matter should be referred to them again for review after the expiration of twelve months. The Committee has now reconsidered this question and has recommended that the golden pheasant should be included in the Schedule for a further period of twelve months, but that the copper and green pheasants should be removed from the Schedule at the end of the present year.

The Board of Trade accordingly desires it to be known that an order will be made in due course, removing the names of the copper and green pheasants from the Schedule, with effect from January 1, 1924.

Science announces that the committee of the Daniel Giraud Elliot Medal desires to receive nominations for the awards of the years 1921 and 1922, which are still open, because the committee has not been able to reach unanimous conclusion on any work thus far brought to its attention. The Elliot Medal is awarded for some especially great contribution, not for general accomplishment, in the field of either zoology or palæontology. It is not restricted in either branch to the vertebrates, but may be made in either the vertebrate or invertebrate field and is open to scientific workers of the world. The award of the gold medal is accompanied by a generous honorarium. Nominations for the two years mentioned, namely, 1921 and 1922, and also for 1923, can now be received. Communications should be addressed to the Secretary of the National Academy of Snccices, Washington, D.C.

THE eleventh meeting of the Indian Science Congress will be held at Bangalore on January 14-19, 1924. H.H. the Maharajah of Mysore will be patron of the meeting, and Sir Asutosh Mookerjee will be president. The following sectional presidents have been appointed :—Mr. B. C. Burt (agriculture) ; Prof. C. V. Raman (physics and mathematics) ; Dr. E. R. Watson (chemistry) ; Prof. K. N. Bahl (zoology) ; Prof. Agharkar (botany) ; Mr. H. Bosworth Smith (geology) ; Lieut.-Col. Christophers (medical research) ; Mr. J. Hornell (anthropology). The honorary local secretaries will be Prof. F. L. Usher, Central College, Bangalore, and Mr. S. G. Sastry, Secretary, Board of Scientific Advice, Bangalore. Further information can be obtained on application to the hon. general secretary, Dr. J. L. Simonsen, Forest Research Institute and College, Dehra Dun, U.P. India.

THE Journal of the Röntgen Society (the oldest radiological society in the world) for July (vol. xix. No. 76) contains an account of the twenty-fifth anniversary dinner of the Society held in March last, and a translation of Röntgen's first and second memoirs on X-rays, entitled "Concerning a New Kind of Ray," which are interesting reading.

THE latest catalogue (No. 378) of Messrs. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, is of a miscellaneous character, but of the 1399 second-hand works offered for sale many deal with science, and, as is usual with the lists issued by this firm, some are very scarce and choice. The catalogue also comprises a list of selected new and recent publications.

THE McGraw-Hill Publishing Co., Ltd., announces an interesting new series of books under the title of "Concise Studies in Economic Problems," which will embody the results of research studies made by the Institute of Economics of Washington, D.C., U.S.A. The first volume will be "Germany's Capacity to Pay." Succeeding works will deal with International Economic Reconstruction, International Commercial Policies, Industry and Labour, and Agricultural Economics.

Our Astronomical Column.

THE DENSITY OF THE CORONA.—The question of the density of the corona is of interest both with regard to possible refraction of starlight in the investigation of the Einstein light-deviation, and with regard to the amount of resistance met with by comets of small perihelion distance. *Astr. Nach.*, 5238, contains a discussion of the subject by B. Fessenkoff, of Moscow.

The author assumes that the total light of the corona is equal to that of the full moon, and that the light intensity varies (1) as the inverse square, (2) as the inverse fourth power, of the distance from the sun's surface. He utilises some studies of his own on the light-reflecting powers of the terrestrial atmosphere at various heights, obtained from measures of the brightness of twilight for different angles of depression of the sun. He calculates that the light given by a small volume of the corona, 5′ from the sun's limb, in terms of the light given by an equal volume of terrestrial atmosphere, of the density and composition that exist at a height of 100 km., placed in the same situation as the coronal volume, is :—on supposition (1) $0{\cdot}52 \times 10^{-3}$; on supposition (2) $0{\cdot}27 \times 10^{-4}$. The density of the corona at 5′ from the limb is that of hydrogen at pressures $0{\cdot}43 \times 10^{-5}$ mm. and $0{\cdot}22 \times 10^{-6}$ mm. (temperature 0° C.) on the two suppositions. It will be remembered that the nearest stars that have been observed in the Einstein investigation were considerably further from the limb.

REPORT ON THE KAPTEYN SELECTED AREAS.—Prof. Van Rhijn, of Groningen, has issued a useful report on the progress of researches on these areas. They are distributed on a uniform plan over the celestial sphere, and are to be studied in an exhaustive manner by a number of co-operating observatories. The first step is the formation of a photographic Durchmusterung of the stars in the areas ; this is being done at Harvard and Arequipa, with apertures of 16 and 24 inches, and limiting magnitudes 15·9 and 16·3 respectively ; these plates are being measured at Groningen. It is estimated that the number of stars is about a quarter of a million, the total area being 225 square degrees, or 1/183 of the sphere. The positions are determined to an accuracy of half a second, the magnitudes to 0·1 mag. The centennial proper motions of the stars of mag. 12 and brighter are determinable to a third of a second with the aid of the *Carte de Ciel* plates ; those of the fainter stars will not be obtainable for some years with the necessary accuracy.

The best methods of determining absolute motions and eliminating magnitude error are discussed ; the author hopes that Kapteyn's plan for a photographic parallax Durchmusterung will not be abandoned. He admits that the results are illusory for particular stars, but he thinks that they will serve to compare the parallaxes of stars of the same magnitude with large and small proper motions. The colour-indices are being determined by Seares by comparison of photographs on ordinary and orthochromatic plates. Altogether the report gives a hopeful summary of the results already attained and those to be looked for in the near future.

Research Items.

TESTS OF NATURAL AND CULTURE PEARLS.—A simple optical method of distinguishing the Japanese "culture" pearls from wholly natural pearls is described by Dr. F. E. Wright in Journ. Washington Acad. Sci., 1923, vol. 13, p. 282. In a bead of mother-of-pearl, such as is always used for the nucleus of the "culture" pearls, the nacreous layers are not concentric to the surface, but are approximately plane, being parallel to the surface of the shell from which the bead was cut. Now normal to this surface the reflecting power, and consequently also the opacity, is at a maximum; whilst at 90° from this direction (that is, looking along the laminæ) there is a minimum of reflection and of opacity. A "culture" pearl when viewed in a strong reflected light (for example, with the observer's back to the sun) shows at the opposite poles of one diameter a small bright spot due to the light reflected from the laminæ of the enclosed bead of mother-of-pearl. In a strong beam of transmitted light (arranged in a closed box with lens and mirror, the pearl resting in a circular aperture) the "culture" pearl shows two positions of maximum opacity, whilst the natural pearl is the same in all positions. A third method, which is applicable also to "culture" pearls containing a real pearl as nucleus, is given by an examination of the walls of the hole drilled through the pearl. The pearl is illuminated by a strong side light and a minute bead melted on the end of a gold wire is inserted in the bore to act as a reflector, which is viewed under the microscope.

CONDENSED MILK.—An important report by Dr. Savage and Mr. Hunwicke on the manufacture, condition, bacteriology, and spoiling of commercial sweetened and unsweetened condensed milk has been issued by the Food Investigation Board (Special Rep. No. 13). The changes in the condition of the milk as a result of its concentration are profound, and not merely those caused by deprivation of water. It is, for example, a much worse conductor of heat than unconcentrated milk. While sporing aerobic bacilli are present in a considerable proportion of samples, decomposition and spoiling are nearly always due to non-sporing bacteria, particularly certain micrococci, which either survive the preliminary pasteurisation of the raw milk in the course of manufacture, or after canning are admitted to the tins through minute leaks. The sources of bacterial contamination and multiplication are mainly from the original milk, from the air of the factory, and particularly from dirty pipes and apparatus. As regards the viability of the micrococci which cause spoiling, in unsweetened condensed milk they may survive a temperature of 70° C., but are destroyed at 80° C. in a short time: this suggests that a longer pasteurisation of the raw milk might be an advantage. The best manufacturers appear to have achieved striking success, however, in dealing with such an unstable substance as milk.

RESEARCHES ON MARINE ANIMALS.—We note with pleasure that Prof. M'Intosh—the veteran naturalist—continues to publish his notes from the Gatty Marine Laboratory, the forty-fifth paper of this series appearing in the July number of the *Annals and Magazine of Natural History*. A note on variation in the wild rabbit is included, but the other items refer to marine animals. The results of a comparative study of the British species of Lepadogaster (Sucker-fishes) are set forth, the characters of the young as well as of the adults being contrasted. The sub-fossil skull of a whale found at Airthrey, near Stirling, is described and figured, and Sir William Turner's conclusion that it pertains to Sibbald's Rorqual is corroborated. A fragmentary skull of *Balæna australis*, from the Campbell Islands, is also described. Finally the variation of *Amphinome rostrata*, a Polychæte worm, is considered, and the conclusion is arrived at that the differences said to exist between specimens from the Atlantic and Indian Oceans are not specific, but are largely due to different methods of preservation. Formalin is condemned as an unsuitable preservative for animals of this group.

VIRUS DISEASES OF POTATOES.—A valuable addition to knowledge of the virus diseases of the potato (Leaf Roll, Mosaic, etc.) has been made by P. A. Murphy, of Dublin, who publishes an account of his work in the current issue of the *Journal of the Irish Department of Agriculture*. It is now well established that what has hitherto been called degeneration of the potato is not due so much to environmental causes as to the presence of infective diseases of which the perplexing feature is that no visible causative organisms have yet been discovered. The menace of these virus diseases to the economic plants of the world seems to be increasing. Already the maize and sugar-cane crops in America have been attacked over large areas of the country. In addition to the potato these diseases (it may be the same disease) in the British Isles attack the tomato, mangel, and the hop. It was shown some years ago by Quanjer in Holland that the infection is transmitted from plant to plant by species of aphis. Mr. Murphy has now proved that other insects infesting the potato, such as various species of Jassid and Capsid, are capable of transmitting infection. In this connexion it is interesting to learn that potatoes when grown in the North of Scotland are not so liable to infection, and it has been suggested that this is due to the absence of disease-carrying insects at a sufficiently early stage of the growth of the plant. Whatever the reason may be, it is undoubted that tubers imported into the south from this region are generally free from disease and produce a much heavier crop of potatoes than that raised from indigenous "seed." Mr. Murphy also shows that certain varieties of potatoes are less liable to infection than others. One of his most interesting experiments was an attempt to secure healthy tubers for "seed" by "rogueing" out obviously infected plants. The result was unfortunately inconclusive, and it appears doubtful whether immunity from attack can be secured by this means. Another perplexing feature of these diseases probably stands in the way. There appears to be no doubt that certain plants (including Solanaceous weeds) act as carriers of the disease, and may therefore be the means of infecting other plants, while showing no visible signs of infection themselves.

TERMITES OF BARKUDA ISLAND.—In a recent part of the Records of the Indian Museum (vol. xxv. part II.) is a memoir on the Termites of Barkuda Island in the Chilka Lake. The systematic characters of the genera and species are described by Prof. F. Silvestri, the habits by Dr. N. Annandale, and the fungi cultivated by the termites by Prof. S. R. Bose. Dr. Annandale divides these termites biologically into three categories—burrowers, mound-builders, and log-dwellers—a classification which, as he points out, does not correspond with the taxonomic one. He discusses the swarming, the duration of life, the cultivation of fungi and the search for food, and the details of structure of the nests.

PARASITIC NEMATODES.—Dr. H. A. Baylis and Mr. R. Daubeny (*Memoirs Indian Mus.*, vii. pp. 263-347) report on the parasitic nematodes in the collection of the Zoological Survey of India. The material, which includes about eighty species, was collected

from animals, mostly Indian, in the Zoological Garden, Calcutta. One of the most interesting records is that of full-sized specimens of *Ascaris lumbricoides* in squirrels. The authors have compared these specimens with others from man and from an Indian wild pig—paying particular attention to the characters of the lips, of the posterior end of the male, and of the eggs—and they conclude that all belong to the same species. *Ancylostoma duodenale* is recorded from the tiger, the specimens being somewhat smaller than those from man, as has been noted in regard to examples previously found in the tiger. *Necator americanus* was found in a new host, namely, a young African rhinoceros which was captured in Tanganyika Territory and had lived in the Calcutta Zoological Garden only a very short time. Two larvæ taken from a prawn are tentatively referred to the genus Eustrongylides, and are apparently the first examples of the genus to be recorded from an invertebrate.

FOSSIL BARNACLES OF INDIA.—The receipt of fresh material at the Natural History Museum has led Mr. T. H. Withers to undertake a revision of the Fossil Balanomorph Barnacles from India and the East Indian Archipelago (*Rec. Geol. Surv. India*, vol. liv). Five species in all are described, three being new, but amongst them the *Balanus tintinnabulum*, of Linné, although often cited in literature, was not to be found, notwithstanding its occurrence in the modern Indian Ocean fauna. One of the new species, *Balanus javanicus*, is closely allied to a recent South African form, and another, *B. indicus*, to a North Pacific species.

INDIAN TERTIARY GASTROPODA.—A fourth, and unhappily last, contribution on Indian Tertiary Gastropoda comes from the pen of Mr. E. Vredenburg, who did not, alas, live to revise the proofs. This part includes the Olividæ, Harpidæ, Marginellidæ, Volutidæ, and Mitridæ (*Rec. Geol. Surv. India*, vol. liv.), and is on the same lines as its predecessors (*cf.* NATURE, May 6, 1922, p. 594). Most of the species described are new and nearly all are excellently illustrated. By an oversight the pre-Linnean name Turricula of Klein, 1753, has been allowed to stand in lieu of Vexillum, Bolten, 1798.

THE GEOLOGICAL EXPLORATION OF AFRICA.—The progressive work of the Geological Survey of Nigeria has already been referred to in NATURE (vol. 110, p. 91, 1922). The fourth of the quarto bulletins, on "The Northern Tinfields of Bauchi Province," price 10s., has now been issued under the care of Dr. J. D. Falconer, and its finish and style of publication testify to appreciative Government support. The illustrations of heat-weathering and water-weathering in granite increase our knowledge of "inselbergs," and the solution-cave in the granite mass near Gohar (Pl. vi) will be a revelation to most geologists. Dr. Falconer's discussion (p. 41) of the origin of the fissures that carry tin ore in the region is of importance in the question of batholitic intrusion generally. He shows how widely spread fracturing may occur in advance of the magma rising from the depths, and how intrusive breccias result from the breaking off of abundant blocks from the zone of shattering. The tin ore may have been introduced to a large extent by vapours heralding the invasion, rather than during the cooling of the "Younger Granite" mass. In Uganda, where "mineralisation" is not obvious, Mr. E. J. Wayland is not so fortunate; he is of necessity working with a temporary staff, and there is a tendency to regard his Survey as a luxury. The Annual Report for 1922 (Entebbe, 1923) shows a wide range of work, including researches on water-supply, and we hope that it may be realised that a Geological Survey, with a geographical as well as a petrological outlook, forms the basis for the understanding of a country. The Geological Survey of Tanganyika Territory, under Dr. E. O. Teale, has issued (1922) what is called a "Final Report," in which details of mineral samples are given, together with some new points as to the Karroo flora of the district. The recommendations show that hopes are entertained of the establishment of a permanent Survey Department.

CONTACT ANGLES IN CAPILLARITY.—The modern industry of ore flotation has its origin in some of the comparatively obscure laws of surface tension, and any observations which throw light on these laws help to provide the industry with a firmer scientific basis. Mr. R. Ablett's paper in the August issue of the *Philosophical Magazine* deals with variation of the contact angle of water with paraffin wax according to whether the solid is stationary or is moving into or out of the water. The wax is in the form of a horizontal cylinder immersed to such an extent that the two liquid surfaces at its sides are horizontal right up to the solid. The angle of contact is then $104\frac{1}{2}°$. On rotating the cylinder about its axis, the angle at the side where the wax enters the water becomes 113° and where it leaves the water 96°, the wax as it were dragging the meniscus with it. For speeds exceeding 4 mms. per second these angles are constant. The author ascribes the change of angle to absorption or inhibition of the water by the wax.

THEORY OF SHIP WAVES.—A contribution to this subject, by Einar Hogner, has been published in the *Arkiv för Matematik, Astronomi och Fysik*, Band 17, No. 12. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: Wheldon and Wesley, Ltd.) The aim of the paper is to investigate mathematically the waves produced by a "forcive" travelling with uniform velocity over a water surface; the investigation being confined to the waves in the vicinity of two boundary planes radiating from the "forcive" and forming an angle of 19°-28′ with the mid wake plane. The author briefly reviews the mathematical explanation of the system of ship waves developed by previous authors, and points out that the theory so developed is valid only for waves at great distances from the ship, and fails in proximity of the boundary planes, where the wave amplitudes become infinite. Furthermore, no waves exist outside the boundary planes, as the approximations introduced make the surface discontinuous at the boundaries. From his modified mathematical treatment, which is given in full, the author deduces that the resultant wave system inside the boundary planes can be considered as constituted by the superposition of two different wave systems, the "transverse" and "divergent." These two systems have a phase difference of 1/3rd of a wave length at the boundaries,—a fact not hitherto noticed by previous writers on this subject. The highest points of the outermost waves are finite and situated at some distance inside the boundary planes, and the resultant wave crests form angles of 56°-44′ with the mid-water plane. The resultant wave systems inside and outside the boundary planes join without discontinuity. The system outside the boundary planes is simple. The mutual situation and direction of the crests of the different wave systems at the boundary are in general found to be dependent on the acceleration of gravitation, velocity of the forcive, and distribution of pressure within the forcive; and the direction depends also on the distance from the forcive.

The Earth's Magnetic Field for 1922.

By Dr. LOUIS A. BAUER.

THE precise constitution of the earth's magnetic field at any one time, and the causes of the constituent fields, are problems of fascinating interest, the solution of which appears destined to reveal hitherto unknown properties of matter. A most intimate knowledge of the earth's magnetic and electric phenomena, as well as a thorough acquaintance with all the latest developments of theoretical physics, seems requisite to success in the proper interpretation of the mysteries presented. Whatever theory is advanced, either for the earth's magnetic or its electric field, a hypothesis must be introduced somewhere implying new properties of matter, or changes in the classical laws of electro-dynamics, or physical conditions below or above the earth's surface, of which we have no knowledge at present. This being so, it behoves us to keep an open mind with regard to any new magnetic or electric phenomena which may come to light.

We fortunately have now three bodies, vastly differing from one another in their physical constitution, the magnetic and electric fields of which may come within the scope of our investigations and help us in our theoretical views, namely—the earth, the atmosphere, and the sun. To anticipate, we now know that the direction of the magnetic axis of each one of these bodies is related in the same way for all three to the direction of rotation of the body, and that the magnetic axis of each is inclined to the axis of rotation, namely, at present, about 11·5° for the earth, about 14° for the atmosphere, and about 6° for the sun. If f be the physical factor, ω the angular velocity of rotation, r the radius, and D the density of the body, then the strength of the magnetic fields of these three bodies, at their magnetic poles for example, may be expressed approximately by a formula of the following type:

$$F = f.\omega r^2 D.$$

The magnetic field expressed by (1) has thus far defied laboratory detection, because of the size and speed of rotation of bodies we may experiment with, but it becomes readily appreciable when we are dealing with a body of mass, size, and angular velocity of rotation comparable with those of a member of our solar system. If (1) holds universally, Jupiter, for example, would be enveloped by a magnetic field of about the same strength as that of the sun. Thus we may have to look for assistance in making notable advances concerning the structure and properties of matter to experiments performed by Nature at large.

The chief questions pertaining to the earth's magnetic field may be stated as follows: (*a*) Is any appreciable portion of the magnetic force observed on the earth's surface to be referred to a non-potential system N? (*b*) Is there, besides an internal magnetic potential system, I, also an appreciable external magnetic potential system, E, existing in our atmosphere? (*c*) If measurable N- and E-systems are disclosed, may any portions arise from relativity effects, R? (*d*) Is the integral of $d\mu$ over the earth's surface and for all constituent systems equal to zero, where $d\mu$ represents the elemental quantity of magnetism, or any other corresponding physical quantity that may evoke a magnetic field? (*e*) What physical conditions must the causes for the various systems fulfil to account for the geographic variations, the secular and other variations?

Any theory of the earth's magnetism and electricity will have to give a complete and satisfying account of these various questions before it can be accepted. Doubtless for some time to come we shall have to be content with trying out working hypotheses and must not permit ourselves to be bound to any one theory. However, encouraging progress has been made, and the object of the present communication is to tell of answers more or less complete to some of our questions.

While the magnetic survey of the globe has been in progress by the Carnegie Institution of Washington and other organisations during the past eighteen years, the writer has published the results of various investigations preparatory to a rigorous and complete analysis of the earth's magnetic field. It thus became possible to decide in what regions of the earth the field work should be intensified, and what additional allied scientific data should be included in the observational programme. Furthermore, to satisfy practical demands for magnetic data, our observational work was so arranged that sufficiently accurate results for magnetic charts could be supplied to leading hydrographic establishments within a few months after the observations had actually been made. Thus for the 1922 magnetic charts of the British Admiralty, as constructed at the Greenwich Observatory, Sir Frank Dyson states that all available material was used, "the greatest source being the observations made by the *Carnegie* and the land observations of the Carnegie Institution of Washington."

Pending more accurate and complete reduction of all observations to a common epoch by the Department of Terrestrial Magnetism than was possible by Greenwich Observatory, a preliminary analysis of the earth's magnetic field for 1922, on the basis of the latest charts and observations, was made by the writer, with the assistance of various members of his staff. The chief results were announced in a lecture entitled "The Greater Problems of the Earth's Magnetism and their Bearings on Astronomy, Geology, and Physics," delivered at the Carnegie Institution of Washington on November 21, 1922. Some later results were also presented at the meetings of the American Physical Society and the American Astronomical Society at Boston on December 30 and 31, 1922.[1] The analysis was made free as possible from assumptions as to the systems composing the entire magnetic field, and was restricted, for the time being, to the region of the earth (86 per cent.) between 60° N. Lat. and 60° S. Lat. Treating the earth as a spheroid of revolution, spherical harmonic series to the sixth degree, and in some cases to the seventh, were established separately for each of the rectangular components: X, positive towards north; Y, positive towards east; and Z, positive towards nadir.

The magnetic data utilised apply in general to longitude-intervals of 10° and latitude-intervals of 5°. Before the polar caps may be safely included in the analysis, the available magnetic data for these regions will require careful examination, and it may be found necessary to await additional data. Some analyses were also made for the regions 30° N. Lat. to 30° S. Lat., and 45° N. Lat. to 45° S. Lat. *There is evidence that the Gaussian coefficients defining the earth's magnetic field, are to be regarded at first as purely empirical quantities and, hence, strictly applicable only to the region of the earth from which they were derived.* It would seem, however, that inclusion of the polar caps will not materially alter the main conclusions given here.

The chief conclusions from our analysis are as follows:[2]

1. For a satisfactory representation of the observed data, it is necessary to recognise the existence of an

[1] *Phys. Rev.*, March 1923, pp. 370-371 and 388; also *Pop. Astr.*, March 1923, p. 186.

[2] For fuller details the interested reader may be referred to *Terr. Mag. and Atm. Elect.* for March-June (pp. 1-28), and September 1923.

internal magnetic system, I, an external system, E, and a non-potential system, N, or of three equivalent systems, X, Y, Z. The I-system constitutes about 94 per cent. of the total magnetic field, and E and N, each about 3 per cent. (There is a possibility that relativity effects, R, may play a part in the exact evaluation of the three systems.)

2. As a resultant effect of all systems causing the secular variation of the earth's magnetism, the north end of the magnetic axis of the I-system during the past eighty years has been moving slowly towards the west, and apparently at the same time slowly towards the equator. The indications from all available data are that if the magnetic axis completely revolves around the axis of rotation, regarding the possibility of which there may be some doubt, the period would not be some hundreds of years, but many thousands of years. The magnetic secular variation results from changes, with lapse of time, both in the direction of magnetisation and in the intensity of magnetisation; the latter quantity has been steadily diminishing during the past eighty years at the annual average rate of about 1/1500 part.

3. A suggestive effect, dependent apparently upon the distribution of land and water, has been disclosed, namely, that the average equivalent intensity of magnetisation for corresponding parallels north and south, is generally larger for the land-predominating parallel than for the ocean-predominating parallel. The secular changes, however, are on the average larger per annum for the south, or ocean-predominating, hemisphere than for the north, or land-predominating, hemisphere.

4. For the earth's internal uniform magnetic field, the following data apply for 1922. The magnetic moment, M, is $8{\cdot}04 \times 10^{25}$ C.G.S.;[3] the components of M, respectively parallel and perpendicular to the earth's axis of rotation, are, $M_p = 7{\cdot}88 \times 10^{25}$ C.G.S., and $M_e = 1{\cdot}60 \times 10^{25}$ C.G.S.; $M_p = 4{\cdot}93\ M_e$. Were the earth's magnetism uniformly distributed throughout the earth, which is not likely, the average intensity of magnetisation would be 0·074 C.G.S. The magnetic axis intersects the North Hemisphere in latitude 78° 32′ North and longitude 69° 08′ West of Greenwich.

There has recently appeared an account of an analysis of the earth's magnetic field, also for 1922, by Sir Frank Dyson and Prof. H. H. Turner.[4] These authors reach conclusions which apparently are at variance with mine given in (1) as to the definite existence of the two systems, E and N. However, a critical examination of the residuals obtained by them when they endeavour to represent the rectangular components, X, Y, Z, on the hypothesis of a magnetic potential due alone to systems below the earth's surface, and assuming that a non-potential system does not exist, is found, in fact, to strengthen my conclusions.[5]

Question (*a*) (*Non-potential System, N*).—The existence of the N-system implies the non-vanishing of the line integral of the magnetic force taken around a closed circuit on the earth's surface. Such line integrals have been computed for large land areas, like the United States, and for very large ocean areas, with data from the cruises of the *Carnegie*, both in the Northern and Southern Hemispheres. The results are so consistent that they cannot be accounted for wholly by observational errors. The analysis of the earth's magnetic field shows that the coefficients derived from the east-west component, Y, will not give an entirely satisfactory representation of the north component, X. A similar experience has been encountered in recent analyses of the diurnal variation of the earth's magnetic field, of magnetic disturbances, and of eclipse effects. Thus the evidence is in favour of the existence of non-potential magnetic systems. The difficulty has been in the adequate *physical* interpretation of the results. According to classical theory, line-integral values are a measure of electric currents passing perpendicularly through the area enclosed by the circuit. The average strength of such indicated currents for the earth's magnetic field is found to be more than 10,000 times that of the vertical conduction current of atmospheric electricity. The average strength of vertical currents that may in part be responsible for the magnetic diurnal variation is about 2000 times that of the currents causing the diurnal variation of atmospheric electricity. We are then forced to conclude that the magnetic line-integrals are a measure of something else than is recorded by atmospheric-electric instruments. Various suggestions are at present receiving careful consideration. The very interesting point was recently raised by Sir Arthur Schuster that no one, so far as he knew, had experimentally verified the generally accepted hypothesis that the magnetic force was accurately at right angles to the current which produced it, and he further remarked that he had very recently come across the statement that according to Einstein's theory the force and the current should not be exactly at right angles. But there are at present difficulties in trying to attribute the observed non-potential effects wholly to such a possible relativity cause.

The general system of vertical currents for the earth's field is as follows: negative electricity flowing into the earth in polar regions and flowing out in lower latitudes; for positive electricity these directions would of course be reversed. The system of vertical currents is unsymmetrical both about the axis of rotation and the equator. (A similar system of vertical currents will explain the present facts of the annual variation of atmospheric electricity.) Enough has been said to show of what extreme interest the final elucidation of the magnetic non-potential effect is likely to be.

Question (*b*) (*External Potential System, E*).—This system is disclosed by the fact that the coefficients determined from the horizontal components, X and Y, will not reproduce completely the vertical component, Z, but will leave outstanding effects of a character which, according to classical theory, can only be explained by an external system of electric or magnetic forces. However, if any portion of the earth's total magnetic field is to be attributed to causes which involve relativity effects, R, then E, in whole or in part, may have to be regarded as resulting from R. It is hoped that a special investigation now under way will throw further light on this interesting question.

As the result, apparently, of the extensive increase in knowledge of the earth's magnetic field over that at the command of previous analysts, the coefficient of the first degree zonal harmonic is found to be three times that resulting from Schmidt's careful analysis for 1885. The magnitudes of Schmidt's coefficients for the various zonal harmonics were such that he did not deem it safe to draw a definite conclusion as to the reality of an external system. The case is different, however, for our 1922 analysis; as stated under conclusion (1), we can no longer ignore the existence of effects similar to those from an external system.

Question (*c*) (*Relativity Effects*).—This question has already received some attention in the consideration of questions (*a*) and (*b*); it also enters into question (*d*).

Question (*d*) (*Is the Integral of $d\mu$ Zero?*).—All analysts beginning with Gauss have assumed that the integral of $d\mu$ is zero. The assumption enters not only into the determination of the coefficients of the

[3] The value of the magnetic moment frequently found in text-books, as dependent on Gauss's analysis for 1830, is $8{\cdot}55 \times 10^{25}$ C.G.S. The average annual rate of loss between 1830 and 1922 is about 1/1500 part, thus corresponding with the annual average rate as given in (2).

[4] Mon. Not. Roy. Astr. Soc., Geophys. Sup., vol. i. No. 3, May 1923, pp. 76-88.

[5] *Terr. Mag. and Atm. Elect.* for March-June 1923, pp. 24-28.

Z-series, but may also require consideration in the derivation of the coefficients of the X-series and of the Z-series, if there is a non-potential system N. So far as the Z-component is concerned, if we do not assume the integral to be zero, a small constant term is added to the Z-series, which slightly improves the mathematical representation. If we have an N-system caused by vertical currents, as already described, then the question arises whether for a limited portion of the earth, for example from 60° N. Lat. to 60° S. Lat., we may legitimately assume that the total amount of electricity leaving the earth equals the total amount entering it in this region; if not, then $\int d\mu$ would not be exactly zero. It is of interest to note that Gauss himself intimated, in his celebrated memoir on the "General Theory of the Earth's Magnetism," that the day might come when it could not longer be assumed that the integral of $d\mu$ is zero. Investigations in progress will further elucidate this matter.

Question (*e*) (*Variations of the Earth's Magnetic Field*).—We now come to crucial tests that may be applied to any theory of the cause of the earth's magnetic field. It would seem as though the surest approach to a solution of the two problems, the origin of the earth's magnetic field and the origin of the earth's electric field, will be by means of the striking variations, geographic, diurnal, annual, sun-spot, and secular, to which they are subject. The two chief sets of variations, which a theory of the earth's magnetic field will have to explain satisfactorily, are: (1) the geographic variations; (2) the secular variations.

Fig. 1 is intended to show how ρ, the equivalent intensity of magnetisation or any other corresponding physical quantity, would have to vary from parallel to parallel in order to produce the portion (about 70 per cent.) of the earth's total magnetic field symmetrical about the axis of rotation, as represented by zonal harmonics to the sixth degree inclusive. If this portion of the field were uniform, then ρ, represented by the radius-vector from O, would be constant; this case is shown by the outer circle. Were the zonal field symmetrical about the equator, then instead of the outer circle we have an ellipse, which has been drawn for each of the two epochs 1885 and 1922 (indicated by broken curves); for this case ρ for the equator would be about 17 per cent. greater than for the combined parallels 60° N. and S. The heart-shaped full curves represent the actual state of affairs for the field symmetrical about the axis of rotation. Comparing the radii vectores, ρ, for corresponding parallels of latitude, north and south, it is seen that for both curves (1885 and 1922) ρ is invariably greater for a land-predominating parallel than for an ocean-predominating parallel, and this fact obtains even for the dotted portions of the curves which apply to the polar regions (see conclusion 3.) It will be noticed that the 1922 heart-shaped curve lies wholly within the 1885 one, just as was the case for the ellipses, and the difference, $d\rho$, between the curves represents, proportionately, the shrinkage in the earth's magnetic moment, or in the equivalent intensity of magnetisation, between 1885 and 1922. It will be noticed that the shrinkage is greater for the south, or ocean-predominating, hemisphere, than for the north, or land-predominating, hemisphere. The effect of the distribution of land and water is one calling for careful examination, and its further study may result in material advancement of our knowledge as to the cause or causes of the earth's magnetic field.

If we wish also to take into account the balance of the earth's magnetic field, about 30 per cent., which is unsymmetrical about the axis of rotation and is represented by the tesseral harmonics, then the pear-shaped solid, obtained by the revolution of the heart-shaped curve about the earth's axis of rotation, would have an irregular surface with specially pronounced humps at the magnetic poles. The radius vector to this somewhat irregular pear-shaped solid would serve to represent the volume or surface distribution of the physical quantity entering into, or evoking, the observed magnetic field. It is clear that no approximately homogeneous spherical iron core inside the earth could produce such a magnetic field as that actually observed.

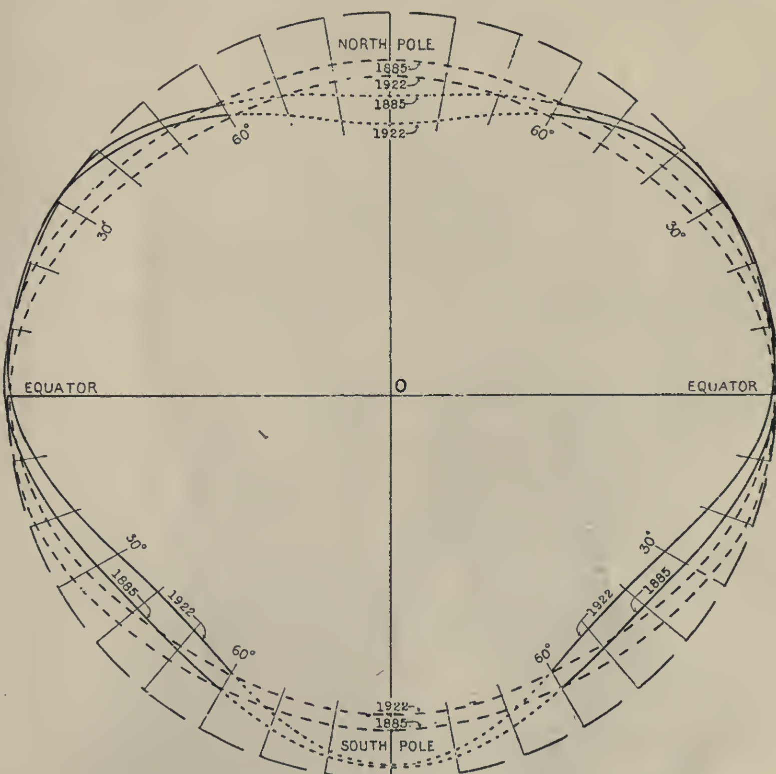

FIG. 1.

Now consider the shrinkage in the earth's magnetic moment. The average annual rate of shrinkage was 1/1000 part between 1885 and 1922;[6] it was found to be 1/2170 part between 1890 and 1900, and about 1/2580 part between 1843 and 1883.[7] Whether the annual rate of shrinkage varies as greatly from time to time as is apparently indicated by these figures is open to question and subject to further investigation with sufficiently trustworthy magnetic data. The steady diminution in the strength of the earth's magnetic field, averaging during the past 80 years about 1/1500 part annually, presents one of the greatest difficulties in the theory as to the cause of the earth's field, the surmounting of which may prove to be the key to the sought-for secret. It should be borne in mind that the annual loss is

[6] *Terr. Mag. and Atm. Elect.*, March-June 1923, pp. 15, 22, and 23.
[7] *Terr. Mag. and Atm. Elect.*, vol. 9 (1904), p. 183.

quite comparable with that of well-seasoned magnets. The loss occurs practically all in the uniform portion of the earth's magnetic field, parallel to a diameter, inclined at present to the axis of rotation about 11·5°; the loss is not made up by any material gain in the non-uniform, heterogeneous portion of the earth's magnetic field.[8] The annual percentage loss is nearly the same for the polar and equatorial components of the uniform magnetic field; and as the equatorial component is only about one-fifth that of the polar component, the absolute annual loss in the earth's magnetic moment results almost entirely from the polar component, *i.e.* the uniform portion of the earth's magnetic field, symmetrical about the earth's axis of rotation, suffers nearly the entire loss.

The system of forces which must be superposed upon the uniform internal magnetic field of 1885 in order to obtain the observed field for 1922 proves to be a demagnetising system, the magnetic axis of which is directed almost diametrically opposite to that of the primary uniform field. A similar result was found in 1904[9] for the period 1890–1900. In brief, the secular-variation system shows the characteristics of the self-induced field of a uniformly magnetised body.

Let us next inquire briefly into which of the quantities in formula (1) so large an annual rate of change for the earth's field as 1/1500 part is to be attributed? Certainly not to the angular velocity, ω, or to the radius, r, or to the density, D, since changes on the order of 1/1500 part in one of these quantities, or in their combined product, would not escape detection by other means. We must conclude that the physical factor, f, contains within itself the kernel for the observed change, but what does this imply?

Let us suppose next that in the factor f we have embodied some physical relation upon which both the earth's magnetic field and its gravitational field depend. Then on the basis of the large average annual loss during the past eighty years in the strength of the earth's magnetic field, we can immediately say that magnetism and gravity are not related to each other as the first power of the factor, for otherwise a correspondingly large annual change in gravity would likewise have been observed. Again, while gravity is greater over the oceans than over continents, the equivalent intensity of magnetisation is, on the average, somewhat less for ocean areas than for continental areas, so here again there is no immediate relation between gravity and magnetism. According to Sutherland's theory[10] which was based on a slight modification of the laws of electrodynamics, magnetism would depend on the first power of a small fraction β (about $2·6 \times 10^{-22}$), and gravity upon the second power; this quantity β would enter into the factor f of formula (1). Accordingly the annual decrease of 1/1500 part in magnetism would imply, on Sutherland's theory, only a decrease of the square of 1/1500 part, or about one-half of a millionth part in gravity, and this is a quantity which may readily escape detection with our present gravity appliances, unless the accumulative effect over many years be carefully observed at several standard stations. Hence, a theory involving gravity and magnetism in the manner prescribed by Sutherland's hypothesis might be admissible. But the observed decrease in the earth's magnetic field-strength would then have to be referred to a corresponding change in β. But what makes β change? It was only meant to represent a very slight variation in the law of action between electric charges; if β changes, so must the new assumed law of electro-dynamics. We have under investigation various hypotheses to account for the observed secular changes in the earth's magnetic field.

Sufficient has been given to show with what extreme care a theory of the earth's magnetic field will have to be formulated and how exhaustively it will have to be examined in the light of the data now known to us. No one who will familiarise himself with the facts will lightly announce the discovery of a new theory of the origin of the earth's magnetism. New and interesting matters may confidently be expected from the discovery of the true cause.

FIG. 2.

In conclusion, Fig. 2 is presented to show the positions of the following points: MA(I), north end of magnetic axis of the earth's uniform internal magnetic field in 1922, latitude 78° 32′ N., and longitude 69° 08′ W.; MA(E), north end of magnetic axis of the earth's uniform external magnetic field in 1922, latitude 76·8° N. and 121·4° W.; and N.M.P., the approximate position of the North Magnetic Pole in 1904, latitude 70·5° N., and longitude 95·5° W. As will be seen, the line of maximum auroral frequency passes to the south of the three positions. (The other lines shown are the routes of the *Carnegie*.) It will be noticed that the displacement of the E-axis is about 52° west of that of the I-axis, and that the N.M.P. is about midway in longitude between I and E. From the amount and direction of displacement of the E-axis with reference to the I-axis, we may deduce further important facts bearing upon the theory of the earth's magnetic field and the possible conductivity of interplanetary space.

[8] *Terr. Mag. and Atm. Elect.*, vol. 8 (1903), p. 107, and vol. 28 (1923), p. 21.
[9] *Terr. Mag. and Atm. Elect.*, vol. 9 (1904), pp. 181-186.
[10] *Terr. Mag. and Atm. Elect.*, vol. 9 (1904), pp. 167-172.

Lichens and their Action on the Glass and Leadings of Church Windows.

By Dr. ETHEL MELLOR, University College, Reading.

THE gradual deterioration and destruction of the stained glass of church windows is a subject of general and scientific interest. It will, therefore, probably be admitted that the technical and practical knowledge of the stained glass artist should be reinforced by the theoretical and laboratory studies of the scientific worker. One of the several possible lines of research was approached nearly three years ago at the Sorbonne under the direction of the late Prof. Matruchot and afterwards of the late Prof. Bonnier.

FIG. 1. (×36.)

(*a*) Opaque discs with beginnings of pits; (*b*) pit bordered by opaque glass.

The deteriorated glass is scaly and iridescent, or pitted and opaque. Both surfaces are attacked, and though the outer shows the greater alteration, it is on the inner that the action is sometimes first apparent. The opacity may extend over the whole surface, but more frequently appears as scattered disc-like points; these gradually get bigger and frequently run together. Meanwhile, the glass at the centre of the original opaque discs disappears and so arise the beginnings of the pits, each bordered by opaque glass and later lined by iridescent scales visible under the binocular lens. As the alteration of the glass continues, the pits increase in diameter and often unite, forming channels of diverse outline and length (Fig. 1). The maximum breadth measured was 5 mm., and depth 1·9 mm. Two pits on opposite surfaces will sometimes increase in depth until the separating wall disappears and a perforation of the glass results. Microscopical examination of the opaque glass shows markings and surfaces similar to geographical contours, and the contortions and cleavages of rocks.

In some cases there is no opacity, and there are no pits. The surface is iridescent and may appear slightly irregular over more or less extended areas. The alteration here takes the form of scaling in thin horizontal plates shown under the microscope to consist of several superposed layers variously cleft and resembling a crazy-tiled garden path.

Unstained and stained glass are similarly deteriorated, but certain colours show more susceptibility to alteration than others. Purple, green, blue, red, amber, and particularly amethyst glasses, are all deeply corroded, while grey tones are less so, and the golden-yellow glass resulting from the vitrification of the silver salts is more or less immune. This immunity is well illustrated in the reproduction of a fragment of fifteenth-century glass (Fig. 2); the surface of the grey and colourless portions is corroded and opaque, and outlines clearly the golden-yellow border and leaf.

There is little reason to believe that the glass of any century is the more frequently or gravely attacked. The glass of the twelfth to the fifteenth centuries is more refractive than that used later and shows a slower rate of alteration, but the cumulative destructive effects are great. The extent of the corrosion does not depend upon age—portions of fourteenth-century glass are still unaltered; specimens of nineteenth-century glass are sometimes badly pitted. The corrosion is of considerable importance æsthetically, but, though it continue until perforation occurs, it does not affect the actual duration of the window; this depends upon the leadings.

The oldest leadings are heavy and have well resisted chemical change; the lighter lead used since the fifteenth century is much more liable to conversion into carbonate of lead, friable and unstable. The transformation is often completed in less than fifty years. This is a matter of supreme importance, for the leadings constitute the skeleton of the window and their appearance remains reassuring after the chemical change has taken place. They are, however, no longer solid, and the crucial moment arrives when an external condition, such as a gust of wind, causes them to disaggregate and allow the glass to fall. It is in this way that so many of the marvellous windows of the last few centuries have perished. This destructive process has been studied and pointed out repeatedly during the last thirty years by M. Félix Gaudin of Paris, a well-known *peinte-verrier*; it cannot be emphasised too much that it is through the leadings and not through the glass that historic windows are often lost.

The alteration of the lead is purely chemical; that of the glass is due to two causes, chemical and mechanical. Strange though it may seem, the windows serve as a substratum for lichens. These plants retain water between their tissues and the glass by capillarity; they also find favourable conditions for growth in proximity to the leadings, which check the drainage where they approach the horizontal plane, and when loose hold water. The amount of carbon dioxide normally dissolved in water is considerably increased by that evolved by the lichens

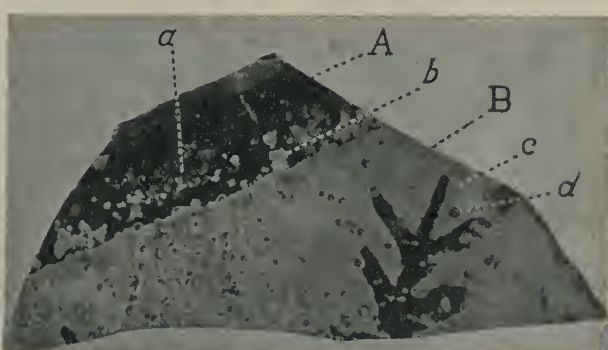

FIG. 2. (Natural size.)

A, Golden-yellow glass: (*a*) scaly glass; (*b*) opaque glass. B, Grey and colourless glass: (*c*) opaque surface; (*d*) pit.

during the process of respiration, and the chemical change of glass and lead is thus accelerated. Evidence of this augmentation of the chemical action is given by the opacity and squamosity of the glass closely following the track of the lichen.

The mechanical action of the lichens accounts for the disappearance of the opaque glass, and the consequent formation of pits and channels. The minute fissures in the opaque glass are penetrated by the lichen hyphæ, which by their varying states of

turgidity, and increase in length and number, loosen the particles and eventually incorporate them in their tissue. The inclusions, always microscopic, occur chiefly in crustaceous thalli below the apothecia and spermogonia, and in the rhizoids of the foliaceous thalli. Vertical sections of the thallus of a *Pertusaria leucosora* Nyl. contained numerous inclusions throughout the lower 0·4 mm. of their thickness.

The inner surface of the glass is the one most frequently squamose. The conditions here are most unfavourable for the development of lichens and usually there is no delimitation of the thallus. The

FIG. 3. (×36.)
(*a*) *Placodium murorum* DC. and circular pit; (*b*) corrosion showing outlines of original pits.

lichen constituents, hyphæ and gonidiæ, are not associated in a definite tissue but exist as a thin layer, resembling a cobweb, over more or less the whole surface, which shows a similar extensiveness in its alteration. Hyphæ and gonidiæ pass between the scales of glass, the former the more deeply, and incorporation follows.

The lichen flora of church windows is practically confined to the exterior, and necessarily limited by the exposed and slippery substratum. Twenty-three species and varieties have been identified, including only one fructaceous, *Ramalina polymorpha* Ach. var. *ligulata* Ach., and two foliaceous, *Xanthoria parietina* Ach. and its variety *tumida* Wed. All the others are crustaceous, these being the best adapted to the environment. There appears to be a succession in the flora analogous to that on a larger scale of the flora of dunes in so far as there is a preparation of the substratum for subsequent species of lichens. A crustaceous species, *Diploicia canescens* Ach., is the most abundant but it rarely occurs except on the unaltered glass; its thallus, of a maximum diameter of 4·6 cm., disappears and leaves a slightly roughened surface. Other crustaceous species follow, two varieties of *Placodium murorum* DC. being most interesting, showing as they do a conformity between their disc-shaped thalli and the circular pits of their substratum (Fig. 3). The crustaceous lichens apparently cease to thrive once the glass becomes deeply corroded, yet it is on this considerably altered surface that the fructaceous and foliaceous species exist (Fig. 4).

The lichens are not well developed. Some are not visible to the naked eye; the thallus is small, mal-formed, incomplete, or greatly sorediﬁed; apothecia are frequently absent or, conversely, persist longer than the thallus. Their determination is difficult, and is often only possible through a prolonged and concentrated study of the gradual change undergone by a species.

Lichens need plenty of air and a certain humidity, with little wind or sun, for their free growth; consequently, windows with a south aspect in the country and all windows in a crowded neighbourhood are unfavourable substrata; they have a scant flora or none at all, and show little deterioration. On windows with a west or north aspect, in humid, calm, but airy surroundings, lichens multiply abundantly and quickly, and the glass shows a correspondingly high degree of alteration. The colour or chemical composition of the glass probably influences the development of lichens, as it is not unusual to see glass of one colour bearing many of these small plants while adjacent glass of another colour is free.

Growth of lichens on windows can be prevented by the simple means of regularly brushing and washing the windows, or by the application of a liquid mastic to exclude air and lichen spores. The essential condition for the ultimate preservation of the windows is that the leadings should receive constant attention and periodic renewal.

The material examined has in the bulk been collected by M. Gaudin throughout Brittany, Normandy, Champagne, Ile-de-France, etc. A certain number of specimens from the Mayenne churches submitted by M. Alleaume, *peinte-verrier* of Laval, are now deposited in the museum of that town.

FIG. 4. (×2.)
(*a*) Circular pit; (*b*) irregular channel; (*c*) corroded border of glass originally inserted in leadings; (*d*) transparent surface; (*e*) lichen debris; (*f*) *Xanthoria parietina* Ach.; (*g*) *Placodium murorum* DC.

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The Liverpool Meeting of the British Association.

LOCAL ARRANGEMENTS.

AN elaborate programme of excursions to places of interest and visits to works has been arranged by the Local Committee. Dealing first with the general excursions, on Thursday, September 13, it is intended that a visit shall be paid to the biscuit works of Messrs. W. and R. Jacob and Co., Ltd., to the United Alkali Works at Widnes, the flour-mills of Messrs. W. Vernon and Sons, Ltd., and the Liverpool Corporation electric power-station, when some of the largest and most up-to-date plant will be inspected. The White Star Line is also inviting a party to view the s.s. *Adriatic*. On Friday, September 14, visits are arranged to Messrs. Bryant and May's match works, to the dyeing and cleaning works of Messrs. Johnson Bros., Ltd., and to the shipbuilding yards of Messrs. Cammell Laird and Co., Ltd. The Cunard Steamship Co. is inviting a party to inspect the s.s. *Franconia*.

On Saturday, September 15, there will be a whole-day excursion to Chester and the River Dee, including a visit to Eaton Hall, by kind permission of the Duke of Westminster. Another whole-day trip will be to the Dolgarrog works of the Aluminium Corporation, Ltd., the party, after inspecting the works, proceeding to Bettws-y-Coed and the Snowdon district. A visit, also occupying the whole day, has been arranged to the Liverpool Waterworks at Lake Vyrnwy.

Of a more general type there will be a day excursion to the Isle of Man, and also by sea to Llandudno and Beaumaris. There will also be a two-day tour (Saturday and Sunday) to the Lake District. On Sunday, September 16, there will be a general excursion by sea to Llandudno and Beaumaris.

On Monday, September 17, visits will be paid to one of the works of the British Insulated and Helsby Cables Co., Ltd., Messrs. Lever Bros.' Soap Works at Port Sunlight, and to the works of Meccano, Ltd., and to the Union Cold Storage, Ltd. A party will also be shown the Liverpool housing scheme, and the Liverpool Salvage Association is inviting those interested to view their plant. The Booth Steamship Co., Ltd., is inviting a party to inspect the s.s. *Hildebrand*.

On Tuesday, September 18, a party will visit the Gladstone Dock and other works of the Mersey Docks and Harbour Board, the Llay Main Colliery near Wrexham, Planter's margarine works at Bromborough Pool, and the large bobbin works of Messrs. Wilson Bros. at Garston.

Of the sectional excursions at present arranged, Section A will visit the Automatic Telephone Manufacturing Co., Ltd., the British Oxygen Co. (Bootle works), and Stonyhurst College; Section B, the United Alkali Co.'s works at Widnes, the Highfield Tannery at Runcorn, Price's Patent Candle Co. at Bromborough, the lactose factory at Haslingden near Crewe, and Messrs. Joseph Crosfield and Co.'s works at Warrington.

Section C will go to Hall Road and Crosby on the north of Liverpool, Storeton Quarries, Burton Point and North Wirral, Lake Vyrnwy district, parts of Flintshire, the Lea Green Collieries and Brick Pits, and Scarth Hill and Skillaw Clough.

Section D is proposing to go a dredging expedition in Liverpool Bay, and to Delamere Forest. Section E is visiting the Liverpool Docks, Storeton, Burton Point and North Wirral, and a river trip to the Eastham Locks of the Manchester Ship Canal, and down the Mersey to the Crosby Channel.

Section F intends to visit the Liverpool Docks and the Cotton Exchange. Section G has arranged one excursion only, and that is to the Gladstone Dock. Section H will inspect the Roman remains at Chester, and will also visit Ince Blundell.

Section I has arranged no sectional excursions.

Section J has one excursion only, namely, to Rainhill, where the County Lunatic Asylum is situated.

Section K is planning to visit the Craven limestone district, Mr. Bulley's gardens at Neston, and the West Lancashire sand dunes near Freshfield. Section L has arranged no excursions. Section M will visit Wirral Farms and Messrs. Gartons, Ltd., at Warrington, and Haslington and the Nantwich district.

Large as this list of sectional excursions appears, if one is to judge from the experience of previous meetings it will be found to have increased by the date on which the meeting commences.

A list of all these excursions and visits will be sent, a short time before the meeting, to members who have intimated their intention of coming to Liverpool, and it will greatly facilitate the work of the Local Secretaries if members will intimate in advance which excursions they would wish to join.

At the close of the meeting in Liverpool there will be an excursion to the Isle of Man, leaving Liverpool on Wednesday, September 19, and returning on Monday, September 24. The party will have an opportunity of visiting all places of scientific interest in the island, but probably members of Sections E and H will find most to study. A special committee in the Isle of Man is making all arrangements, and details will, it is hoped, be completed by the opening day of the meeting in Liverpool.

Although perhaps it does not so much concern the actual members of the Association, yet a definite item in the programme of the meeting is the series of public lectures. The number of these it is proposed to give in Liverpool will be greater than in any town previously visited by the Association, and further, one will be given in Bootle, Wallasey, Birkenhead, Runcorn, Warrington, Wigan, and, St. Helens, while two lectures to young people will be given in Liverpool and one in Birkenhead and Warrington. It is the hope of the Local Committee that these lectures will prove a great success, and so develop one of the prime objects of the Association, namely, to promote interest in science and its applications. ALFRED HOLT.

International Hydrography.

MANY abortive attempts were made before the War to found an international hydrographic organisation, but success was not achieved until after the War, when a conference was held in London, in 1919, at the invitation of the British Admiralty, with the cordial support of the French hydrographic office. Twenty-one states were represented at the conference, invitations having been sent to all countries likely to be interested, with the exception of the Central Powers, Russia, and Turkey. As a result an International Hydrographic Bureau was instituted in 1921, and all the States represented at the conference have now associated themselves with it. The Bureau has its official seat at Monaco. Soon after its institution it became affiliated to the League of Nations, and it uses the official languages of the League, namely,

English and French. Its three chief officials are Sir J. D. Parry (Great Britain), Admiral Phaff (Netherlands), and Captain Müller (Norway), the first-named being president. It confines itself to hydrography in the strictly nautical sense of the word, and one of its chief objects at present is the international standardisation of practice in relation to many maritime matters. For example, in relation to charts, among the questions which arise are those of the type of projection, the scale, the choice of units for depth and distance, the mode of delineation of soundings, the symbols and abbreviations, and the geographical names to be used. Lists of lights, sailing directions, and distance tables are other matters on which more uniformity and co-operation would be advantageous. It may be noted that most countries now use metric units for depth, Japan being one of the latest formally to adopt this system, though it has not yet actually introduced it. Great Britain and America are now the only States which exclusively use the fathom and foot, but the change to the metric system is one which they are as yet unwilling to make, because of the great difficulty and cost of altering the copper plates from which are printed the exceptionally large number of charts which these countries produce.

The Bureau has recently started a journal, the *Hydrographic Review*, of which the first number appeared in March last. It is bilingual, all its contents being duplicated in English and French, on opposite pages. A large part of the first issue is devoted to the history of the inception of the Bureau, and other official matters. The chief original articles consist of two reports on aerial photography as applied by the French and Netherlands services to hydrographic surveying and the discovery of shoals and covered rocks. There is also a discussion of the visibility of lights, considering the chances which a sailor has of sighting a given light in different circumstances at various distances, and a brief report on echo sounding as practised by the United States hydrographic department.

The Age of the Earth.[1]

SINCE the advent of our knowledge of radioactive processes, the old controversy over the age of the earth has been revived, and although there is now a marked change of opinion in favour of the longer estimates, it remains unfortunately true that there still appear to be tantalising discrepancies between the results from different methods. These discrepancies may be mitigated or exaggerated by special pleading, but they still stand in the way of an unequivocal settlement of the problem.

Twenty years ago various attempts were made to squeeze geological history into the narrow limits imposed by Kelvin and Tait. The discovery of radioactivity, and more recent advances in the study of stars and tidal friction, have destroyed the value of the older physical evidence, leaving various geologists committed to what are now seen to be absurdly low figures. In the last decade the geological methods have in turn been widely criticised, and the present tendency is greatly to extend the estimates formerly favoured. All the methods adopted depend on the rate of processes at present in operation. In order that the different lines of evidence should converge, it is necessary to suppose either that the rates of geological processes are at present too high, or that those of radioactive processes are too low, to justify integration over the whole duration of geological time.

In the symposium under consideration, held in Philadelphia on April 22 last year, the chief feature of interest is Chamberlin's spirited attempt to show how the geological estimates may be brought into harmony with the revised deductions from radioactivity and astronomy. The period required for the deposition of the whole of the sedimentary column or for the accumulation of salt in the oceans is easily arrived at from existing data on the assumption that present rates provide a characteristic average. There is now little doubt that this assumption is deceptive, and it certainly can no longer be admitted. De Geer's work on the yearly deposits from glacial waters in Sweden, though an exceptional case, suggests to Chamberlin a Glacial epoch fully twenty times as long as that assigned by the old methods. He further expresses the conviction that breaks in the continuity of more normal sediments, the time-values of which are best judged by comparison of the faunas above and below, must, when finally interpreted, greatly extend the simple arithmetical estimates. It has frequently been shown how denudation and deposition must be quickened up by human activities, and the effects of cultivation and excavation have been ably analysed by Dr. Sherlock in his recent "Man as a Geological Agent." Existing conditions also naturally favour a high rate of denudation, since continental elevation and breadth are both exceptional, and to these may be added the further consideration that broad areas are strewn with easily removable glacial deposits. So variable are the factors involved that there is no means of arriving at average rates which would properly include long periods of sea-transgression and base-levelling, periods when denudation was brought almost to a standstill.

The validity of the method based on the accumulation of salt in the oceans depends partly on the rate at which the present streams are carrying sodium down to the sea—a rate which must be too high for reasons already mentioned—and partly on the irreversibility of the process. It has, of course, been generally recognised that sodium returns to the land in interstitial solutions held by sediments and as wind-borne salt, but other possibilities have been less emphasised. Actually it is found that the data used are inconsistent among themselves unless other cyclic processes are involved. The most serious discrepancy is found in the ratio of sodium to chlorine, which in igneous rocks is about 30 : 1 and in the oceans about 1 : 1·8. When volcanic exhalations are taken into consideration this enormous difference is reduced but by no means wiped out. Clarke and Washington have given figures which include the whole of the atmosphere and hydrosphere, and the discrepancy still remains as high as 20 : 1.

There can be only one explanation: that chloridised sodium plays a far greater part in cyclic action than has yet been detected. In the case of potassium such circulation is all-important and is effected by its greater retention by muds and soils. Dr. Milton Whitney writes, "Ocean shore deposits would undoubtedly absorb NaCl up to the point where the colloids were in equilibrium with sea water," but as to the relative efficiency of this and analogous processes there is still no exact knowledge. The sodium method is thus, as Chamberlin says, "not yet ready to render a verdict." As to the sedimentation method,

[1] From the Geological View-point. By T. C. Chamberlin. From the Paleontological View-point. By J. M. Clarke. From the Point of View of Astronomy. By E. W. Brown. The Radioactive Point of View. By W. Duane. (Proc. Amer. Phil. Soc., vol. lxi., No. 4, pp. 247-88, 1922. Philadelphia.)

he concludes that the cumulative effects of present-day conditions need not be strained to bring the older estimates up to the same order as those required by current deductions from radioactive minerals.

The remaining papers call for little comment. Palæontology presents faint hope of arriving at a trustworthy or even approximate conclusion as to the age of the earth, for no measure of the rate of vital processes has yet been devised. The endurance of an index species provides no firm basis for a definite calculation of the duration of a zone, or *phase*. Astronomical considerations have recently afforded support to the figures suggested by radioactivity for the age of the earth, but there is here no discussion of the work and views of Eddington, Jeffreys, or Shapley. Similarly the paper on the "Radioactive Point of View" omits to mention the interesting speculations of Joly, which are so ingenious that they will demand a thorough discussion in the future, even though in the present stage of knowledge they may be coldly regarded by physicists.

Arthur Holmes.

University and Educational Intelligence.

Cambridge.—Dr. P. Kapitza, Trinity College, has been elected to the Clerk Maxwell Scholarship.

The London County Council's programme for 1923–24 of lectures and classes for teachers comprises some 600 items grouped under the headings art, domestic subjects, economics and political science, languages and literature, geography, handicrafts, history, mathematics, music, pedagogy, phonetics, physical education, science, miscellaneous. The science group includes 52 items, namely, wireless, 5 (Prof. J. A. Fleming); history of science, 10 (Dr. C. Singer); psychology of vocational guidance, 5, and the neurotic child, 5 (Dr. Cyril Burt); bacteria, moulds, and yeasts, 5 (Dame Helen Gwynne-Vaughan); mental deficiency, 6; British weather, 6 (Sir Napier Shaw); animal parasites and pests, 5 (Dr. Philippa Esdaile); and Kew Gardens, 5 (Major Chipp). Moreover, the pedagogy group includes no lectures on the teaching of science. The lectures "are designed to bring London teachers in touch with the latest developments in educational technique and to give them opportunities, as well, for coming into touch with expert opinion on questions of national and civic importance. The lectures largely reflect therefore those questions which are the subject of topical discussion." The choice of subjects is limited by the fact that the scheme has to be self-supporting, and this may be the reason why no provision is made for lectures on civics, home-economics (except a course on domestic handicraft), nature-study, or general science. The lectures are open to all teachers actually employed in teaching within London at a fee of one shilling or less per lecture, and to teachers from outside at rates 50 per cent. higher. The attendance last year was 20,000. Several scientific societies place at the disposal of the London County Council a certain number of tickets of admission to their ordinary meetings for distribution to teachers of science in London schools.

British women students wishing to spend the coming academic year studying in Paris may like to know that three residence scholarships for British graduates studying at the Sorbonne or other institution of higher learning in Paris are offered by the American University Women's Club, 4 Rue de Chevreuse. The value of each scholarship is 350 francs per month for nine months, and the rates charged by the Club are such that each scholar would need to pay an additional 500 francs a month, *i.e.* about 60*l.* for the nine months. Applicants for these scholarships should send their names, stating their age, academic qualifications and proposed course of study, to the Secretary, International Federation of University Women, 92 Victoria Street, S.W.1, not later than September 15. Each application should be supported by at least two references permitted to persons well acquainted with the candidate's career.

The use of the local environment of the school as a starting-point and source of material and interest in that school without exploiting it for vocational training is discussed in Rural School Leaflet No. 11 of the United States Bureau of Education, in which an attempt is made to show in detail how this principle should be applied in agricultural districts. It appears that in 17 states the teaching of "agriculture" in the elementary schools throughout the state has been prescribed by law somewhat precipitately, without regard to the fact that teachers with the requisite special training are not available and without any clear definition of objectives or methods. Such precipitation is, the writer points out, the more to be deprecated in view of the exceeding complexity of agriculture alike on the side of natural science, every branch of which it lays under contribution, and on the side of practice, wherein it involves not only a great variety of arts but a mode of living. At the same time this very complexity makes a naïve experience of agricultural happenings invaluable as a starting-point and source of material and interest. Dealing with the social and economic aspects of the subject, he contends that even in the elementary schools teachers should not fail (as they have failed in the past) to emphasise the necessity of the organisation of farmers as a means of economy in distribution and self-preservation in the struggle for existence in competition with other organised groups.

Developments in medical education in the United States during the past 20 years, and especially during the years 1920–22, are summarised by Dr. N. P. Colwell in Bulletin 18 of 1923 of the U.S. Bureau of Education. Since 1904, when the American Medical Association started a campaign for raising educational standards, the developments in respect of medical school admission requirements, laboratory and library equipment, number and calibre of whole-time professors, and arrangements for clinical instruction, have been such that these standards, formerly lower than those of the principal European countries, can now challenge comparison with any in the world. Simultaneously the number of schools has been reduced by one-half—from 162 to 81—and the number of students from 28,000 to 13,000 in 1919, since when they have increased to 18,000. Of 81 schools, 66, rated as class A, require two years of college work as a condition precedent to entry on their four-years' course. Although students' fees, which formerly covered the cost of maintenance of the schools, have been largely increased, they amount now to little more than one-third of the cost. Along with improvement in medical schools has gone a corresponding advance in the standard of qualifications required by state medical licensing boards, but the laws on the subject have to some extent been stultified by the existence of sectarian "schools" with low educational standards, which have not been made subject to medical practice laws although their graduates assume the responsibility of undertaking to heal the sick.

Societies and Academies.

PARIS.

Academy of Sciences, July 23.—M. Albin Haller in the chair.—H. **Deslandres**: Mountain observatories. A description of the heights, position, and equipment of the existing mountain observatories. The four American observatories (Lick, Arequipa, Flagstaff, Mount Wilson) can be occupied all the year round, are equipped with large instruments, and have already produced important results: of the others, those on Mont Blanc, Pic du Midi, and Etna are insufficiently equipped and observations can be made only for a short period of the year. For a new French observatory Revard (near Aix-les-Bains) and Fort Romeu (Pyrenees), altitudes 1500 metres and 1800 metres respectively, have been examined. Fort-Romeu possesses the advantages of possible occupation all the year round and ease of access.—G. **Bigourdan**: The use of a completely free pendulum as a chronometer.—F. E. **Fournier**. The forms of hull most favourable to high speeds are only realised in racing automobiles.—**de Séguier**. Linear groups with bilinear or quadratic invariant in the real and complex field.—S. **Sanielevici**. An application of the tensorial calculus.—**Evans**. Poisson's integral.—F. H. **van den Durgen**: Some technical applications of integral equations.—Emile **Bélot**: An attempt at the representation of the period of continuous evolution, t, of the stars as a function of the effective temperature, θ. Application to the sun.—R. **Jarry-Desloges**: The influence of the various elements of an objective (aperture, focal distance, magnification) on the quality of telescopic images. Diaphragms smaller than two-thirds of the diameter of the objective cannot be usefully employed. As regards magnification there exists an optimum focal length of the refractors, between 6 and 6·75 metres: this result is new and difficult to explain.—E. **Selety**: The possibility of an infinite potential, and of a mean velocity of all stars equal to that of light.—Wladimir **de Bélaévsky**: A problem of elasticity in polar co-ordinates.—Th. **De Donder**: Synthesis of the gravific.—Camille **Gillet**: Aqueous solutions. The origin of osmotic effects. Starting with the assumption that water is a mixture in equilibrium of hydrol (H_2O), dihydrol $(H_2O)_2$ and of polyhydrol $(H_2O)_n$, of which the first is gaseous, a theory is developed affording an explanation of the existence of osmotic pressure, flocculation of solutions and of sols by electrolytes, the flocculation of sols by other sols, and the formation of emulsions.—A. **Boutiric** and M. **Vuillaume**: Study of the absorption spectrum of sols of arsenic sulphide.—Alfred **Gillet**: Researches on electrodiffusion (migration of the ions). Experiments on the migration of the ions in jellies (gelatine) containing sodium sulphate. A. **Lassieur**: The electrolytic estimation of antimony. If a thin coating of mercury is deposited on the cathode, and the potential not allowed to go over 1·3 volts, the antimony subsequently deposited electrolytically is coherent and accurately corresponds with the weight of metal present.—L. J. **Simon**: The sulphochromic oxidation of the aromatic hydrocarbons and the present conception of graphite. Comparison of the oxidation of aromatic hydrocarbons by sulphuric acid with chromic acid and silver bichromate, together with the results of the application of the silver bichromate reagent to various forms of carbon and coal.—L. S. **Glichitch**: The estimation of easily dehydrated alcohols in essential oils. The estimation of free alcohols in essential oils by acetylation fails in the case of certain alcohols, water being removed and hydrocarbons formed. By replacing acetic anhydride by a mixture of this substance with formic acid, this difficulty is overcome.—J. **Orcel**: The bavalite of Bas-Vallon.— — **Thiébaud**: Researches on the mineralogical composition of some chalk marls of the Tertiary of Alsace.—A. **Cholley**: Evolution of the karstic relief of the Parmelan (Préalpes de Savoie).—Henri **Coupin**: The supposed formation of chlorophyll in the dark. Experiments are described contradicting the view that etiolated plants can manufacture chlorophyll in the dark.—Jean **Politis**: The formation of a glucoside (saponarine) in the mitochondria.—A. **Demolon** and P. **Boischot**: The activity of the biological phenomena in peat. The relative passivity of peat from the biological point of view is due to the poverty of the medium in nutritive elements, and especially phosphoric acid, and the results of the partial sterilisation of peat by heat cannot be attributed to destruction of toxins or to an action on the protozoa.—A. **Quidor** and Marcel A. **Herubel**: The psycho-physiology of visual phenomena.—Paul **Benoît**: The polar globules of the egg of *Tubularia mesembryanthemum*.—Jean **Camus**, J. J. **Gournay**, and **Fiterre**: The mechanism of insipid diabetes.—E. **Lesné**, L. **de Gennes**, and **Guillaumin**: The action of light on the variations of calcemia in rickets.—A. **Juillet**: Remarks on the note by MM. Chevalier and Mercier on the pharmacodyamic action of the insecticidal principle of pyrethrum flowers.

SYDNEY.

Linnean Society of New South Wales, June 27.—Mr. A. F. Basset Hull, president, in the chair.—G. I. **Playfair**: Notes on freshwater algæ. A series of miscellaneous notes on algæ, in which twelve species and fourteen varieties are described as new; and remarks made on the development and life-history of many species.—Miss M. I. **Collins**: Studies in the vegetation of arid and semi-arid New South Wales. Part i. The plant ecology of the Barrier District. The paper consists of an introductory section in which the chief physiographic units of New South Wales are discussed in reference to the formation of the Great Western Plains. The geologic, physiographic, and climatic features of the Barrier Range are described, accompanied by an account of the chief plant associations, and lists of species for the different habitats. In a final discussion the developmental relationships of the associations are indicated.—Miss Marguerite **Henry**: A monograph of the freshwater Entomastraca of New South Wales. Part iii. Ostracoda. This paper gives brief descriptions of thirty-six species of Ostracods, with their synonymy and keys for their identification. Seven species are described as new, two are recorded for the first time in Australia and one for the first time in New South Wales. A freshwater member of the family Cytheridæ is recorded for the first time in Australia. Lists are also given of the species that are known to occur in other States.

Official Publications Received.

United States Department of Agriculture. Department Bulletin No. 1165: Report on Bird Censuses in the United States 1916 to 1920. By May Thacher Cooke. Pp. 36. (Washington: Government Printing Office.) 5 cents.

University of Liverpool: Tidal Institute. Fourth Annual Report, 1923. Pp. 7. (Liverpool.)

University of Colorado Bulletin. Vol. 23, No. 8, General Series No. 192: Catalogue, 1922–1923, with Announcements for 1923–24. Pp. 489. (Boulder, Colo.)

Supplement to NATURE

No. 2808 AUGUST 25, 1923

The Life History of an α-Particle.[1]

By Sir ERNEST RUTHERFORD, F.R.S.

IN this lecture I propose to discuss some of the properties of the high-speed α-particle which is spontaneously ejected from radioactive substances. This flying atomic nucleus is not only the most energetic projectile known to us, but it is also an agent of great power in probing the structure of atoms, so that an account of the effects produced by it is of wide scientific interest.

It is now well established that the α-particle expelled from radioactive bodies is in all cases a helium atom, or, to be more precise, the nucleus of a helium atom of mass 4 carrying two positive charges of electricity. It is only when the expelled nucleus is stopped by its passage through matter that it captures the two negative electrons required to convert it into the neutral helium atom. It is natural to suppose that the helium nucleus, which is shot out at great speed from the heavy nucleus of a radioactive atom, formed part of its structure. For some reason, which is not as yet understood, occasionally one of the radioactive nuclei breaks up with explosive violence, ejecting the component helium nucleus with high velocity. It is probable that the α-particle in escaping from the radioactive nucleus acquires part of its great energy of motion in passing through the repulsive electric field surrounding the latter, but at present we do not know the nature of the forces which hold the complex nucleus together, or whether the α-particle is at rest or in orbital motion in the nuclear structure before instability sets in. We know, however, that there is a very wide range of stability exhibited by different radioactive elements. In a substance like radium A, the average life of the radioactive atom before ejection of an α-particle is about 4·3 minutes, for radium itself 2250 years, while in the case of a very slowly changing element like uranium the average life is of the order of 7000 million years.

It is known that the α-particles from a given element are all shot out with the same speed but that this speed varies from element to element. There is apparently a close connexion between the velocity of ejection of the α-particle and the average life of the parent element. The shorter the average life of the element, the swifter is the speed of expulsion. This interesting relation between the violence of the explosion and the average life of the element holds in the majority of cases, but it is difficult at present to be at all clear of its underlying meaning. Sir William Bragg long ago showed that the α-particle travels through matter nearly in a straight line, and has a definite range of travel in a substance. This is well illustrated by the tracks of α-particles obtained by Wilson's expansion method. The majority of the tracks are seen to be quite straight, apart from an occasional deflexion near the end of the path. At the end of the range the photographic and ionising effects of the α-particle apparently cease with great suddenness. On account of its great energy of motion, the individual α-particle can be detected by the scintillation it produces in crystalline zinc sulphide, by the effect on a photographic plate, and by special electrical methods, while the beautiful expansion method of Wilson shows the trail of each individual α-particle through the gas.

We are enabled, particularly by the scintillation method, to count the individual particles, and thus we have at our command a method of great delicacy for studying the effects produced by the passage of α-particles through matter. In travelling through a gas the α-particle passes through the outer electronic structure of a large number of atoms and liberates electrons, thus giving rise to an intense ionisation along the track. The ionisation increases to a maximum near the end of the path of the α-particle and then falls rapidly to zero.

A careful study has been made of the law of decrease of velocity of the α-particle in passing through matter by studying the deflexion in a magnetic field of a pencil of α-particles before and after its passage through a known thickness of matter. In most of these experiments we employ the α-particles of radium C, which have a range of about 7 cm. in air under ordinary conditions. The initial velocity V_0 of these particles is known to be 19,200 kilometres per second, and the reduction of velocity can readily be followed down to about 0·4 V_0. At this stage the emergent range of the α-particles is less than one centimetre, and measurements are difficult, owing to the fact that a beam of α-particles becomes heterogeneous and contains particles moving with different velocities.

[1] Discourse delivered at the Royal Institution on Friday, June 15.

For this reason the velocity of the α-particle cannot be followed with certainty below 0·38 V_0. We must bear in mind that even at the lowest velocity at which it is possible to detect the α-particle by the scintillation or photographic method, it is still moving at a high speed compared with the positively charged particles generated in an ordinary discharge tube.

It is clear that ultimately the α-particle must be slowed down to such an extent that it captures electrons and becomes a neutral atom, but until recently no evidence of this process of capture of electrons had been obtained. G. H. Henderson (Proc. Roy. Soc. A, 102, p. 496, 1922) has recently added much to our knowledge of this subject by examining the deflexion of α-rays in a magnetic field in a very good vacuum. For the success of these experiments it is essential that the apparatus in which the deflexion is observed should be exhausted to a very low pressure, corresponding to that required for a good X-ray tube. The reason of this will be seen later. When a narrow pencil of α-rays was deflected in a magnetic field two bands were observed on the photographic plate, one the main band, due to ordinary α-particles carrying two positive charges, and another midway band which he supposed to consist of particles which had captured one electron, *i.e.* to singly charged helium atoms. At low velocities he also obtained evidence of the existence of neutral α-particles resulting from the capture of two electrons by the helium nucleus. In these experiments Henderson employed Schumann plates, where the film is so thin that low velocity particles produce as much or more photographic effect than the swifter particles.

I have repeated these experiments; by the scintillation method, and confirmed the deduction of Henderson. By observing the deflexion of the midway band in an electric as well as in a magnetic field I find there is no doubt the particles composing the midway band consist of particles of mass 4 and charge 1, *i.e.* to singly charged helium atoms which have the same speed as the doubly charged particles comprising the main band.

Some recent experiments have been made by me to throw light on the conditions under which the flying α-particles may gain or lose an electron. The general arrangement of the experiment is shown in Fig. 1. A fine platinum wire coated with radium B+C, by exposure to the emanation (radon) serves as a nearly homogeneous source of α-rays, since the α-particles are emitted only from the atoms of radium C, which are too few in number to form a film on the platinum of even one molecule thick. The α-rays from this source pass through a narrow slit about 0·3 mm. wide and fall on a screen of zinc sulphide. The distribution of α-particles on the screen is determined by the scintillation method in a dark room, using a microscope outside the box. The vessel containing the source and screen is completely exhausted by means of a Gaede and mercury diffusion pump, and if necessary the residual pressure can be measured by a Macleod gauge. The box is placed between the plane pole pieces of a large electromagnet so that the pencil of α-rays is bent in the direction shown in the figure. Usually the distance between the source and screen was 16 cm., with the slit midway. The whole path of the rays was exposed to a nearly uniform magnetic field and the deflexion of the pencil of rays was proportional to the strength of the magnetic field. Under normal experimental conditions the pencil of α-rays from the

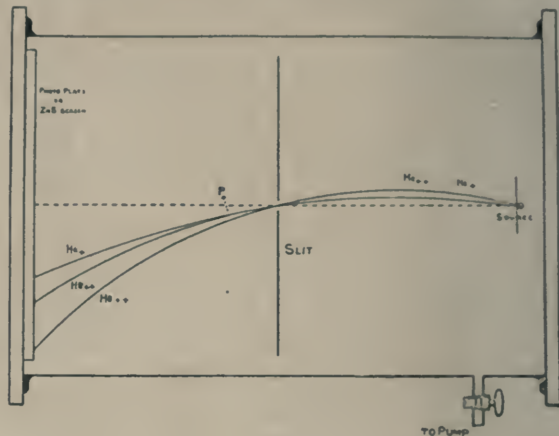


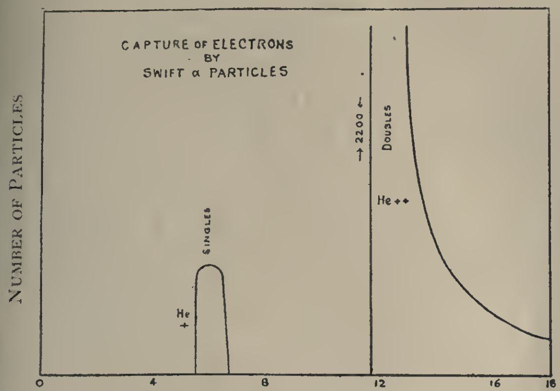
FIG. 1.

bare radium C wire was bent a distance on the screen of about 15 mm. from the zero position without field. The field of view of the microscope was sufficient to take in the depth of the whole pencil of α-rays without the field.

Special precautions were taken to prevent contamination of the screen by the escape of active matter from the wire in a low vacuum. It must be borne in mind that the type of wire source employed always introduces some heterogeneity in the beam of α-rays even from the uncovered source. This is due to the escape from the back of the wire of α-particles which are reduced in velocity in passing through the material. This effect is clearly manifest when the pencil of α-rays is deflected by a magnetic field; for in addition to the main band of α-rays there is always a distribution of particles extending beyond the main beam. The intensity of this heterogeneous beam at any point is generally less than one per cent. of the main beam and does not seriously interfere with the accuracy of the deductions discussed in this lecture.

In Figs. 2 and 3 are given illustrations of the distribution of singly and doubly charged α-particles

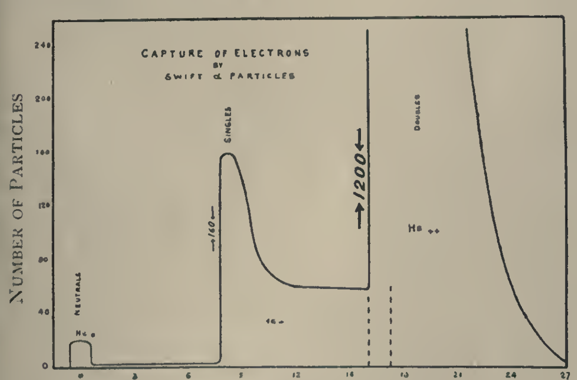
along the zinc sulphide screen. Fig. 2 shows the result when a thickness of mica corresponding in stopping power to 3·5 cm. of air is placed over the source. The main band, due to He_{++} particles, is sharply defined on the high velocity side, but there is evidence of some heterogeneity produced in the beam by its passage through the mica. As we should expect, the midway



DEFLEXION IN MM. BY MAGNETIC FIELD

FIG. 2.

band (He_{+} particles) lies exactly between the zero position and the main band and contains only about 1/55 of the particles in the main beam. Fig. 3 shows the distribution when the thickness of mica is increased to correspond to a stopping power of about 6 cm. of air. Both the main and midway bands are no longer sharply defined as in the first case, but each

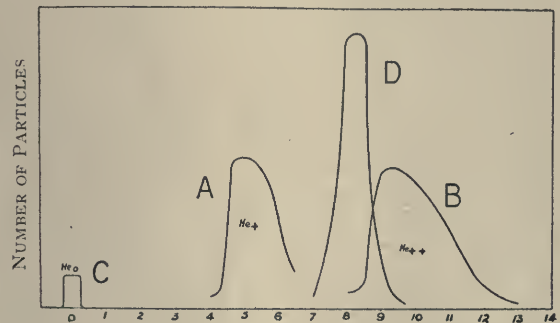


DEFLEXION IN MM. BY MAGNETIC FIELD

FIG. 3.

consists of particles with a considerable range of velocities. The relative number of He_{+} and He_{++} particles is about 1/8 for the swifter particles, but this ratio increases with decreasing velocity. The midway band extends and joins the main band where it can no longer be followed. The brightness of the scintillations due to He_{+} particles falls off obviously and continuously from A to B. At this stage, too, some neutral particles make their appearance. This is shown by the He_0 band, which is not deflected by a magnetic field, but its intensity is small compared with that of the midway band. There is also a sparse distribution of faint particles between the neutral and midway band, probably due in part to scattering of the α-particles by the edges of the slit and possibly in part due to recoil atoms of oxygen and other elements constituting the mica. The distribution of the charged and uncharged helium particles for a still lower velocity will be seen in curves A, B, Fig. 4, which will be referred to later. It is seen that the relative number of He_{+} to He_{++} particles has increased; similarly, the relative number of neutral particles is much greater.

We may now consider the interpretation to be placed on these observations. It is clear that the particles emerging from the mica consist of doubly charged, singly charged, and neutral particles, but the relative number of these three types varies markedly with the stopping power of the mica plate. We may suppose that the α-particle in passing through the outer electron



DEFLEXION IN MM. BY MAGNETIC FIELD

FIG. 4.

structure of the atoms in its path occasionally removes and captures an electron. This electron falls into a stable orbit round the doubly charged helium nucleus and moves with it.

This singly charged atom will, however, have only a limited life, for in passing through other atoms the electron is knocked off and the singly charged α-particle reverts back to the doubly charged type. This process of removal is analogous to the ordinary process of ionisation where an electron is ejected from an atom by a collision with an α-particle; for as a singly charged particle can remove electrons from another atom, so there is a chance that the He_{+} particle should lose its attendant electron. We may thus consider that two opposing processes are at work, one resulting in the capture of an electron and the other leading to its removal. From the data given later it will be seen that this process of capture and loss may repeat itself more than a thousand times in the flight of an α-particle, so that the average path travelled by an α-particle before capture of an electron or before loss of the captured electron is small compared with the total

distance of travel of the α-particle before it comes to rest. It is clear from this, for a given velocity of α-particle, that there must be a momentary equilibrium between the number of He_+ and He_{++} particles such that, on the average, the number of captures in a given small distance is equal to the number of losses.

It is very convenient to suppose that for a given velocity each He_{++} particle has a mean free path λ_1 cm. in the material before it captures an electron, and the He_+ particle a mean free path λ_2 cm. before it loses its attendant electron. No doubt some of the individual particles travel distances much shorter or longer than this mean distance before either capture or loss, but in considering a large number of particles we may suppose there is an average distance traversed before capture or loss, to be called the mean free path.

When N_1 He_{++} particles traverse a small distance dx of a material the number which capture electrons is $N_1 dx/\lambda_1$. If N_2 He_+ particles are present the number which lose an electron is $N_2 dx/\lambda_2$. But we have seen that when an equilibrium is set up, the number of captures in a given distance must equal the number of losses. Equating these two expressions, it is seen that $N_2/N_1 = \lambda_2/\lambda_1$, or, in other words, the relative number of He_+ to He_{++} particles is proportional to the ratio of the mean free path for loss to that for capture. Since by the scintillation method the ratio N_2/N_1 can be measured for any velocity, by using different thicknesses of absorber we can thus determine the ratio of the mean free paths for capture and loss for any velocity.

The actual value of the mean free path λ_2 of the He_+ particle before it loses its electron can be directly determined by experiment. Suppose the microscope is focussed on the midway band of Fig. 2 and the number of scintillations per minute observed in a good vacuum. If the pumps are shut off and a small quantity of air or other gas is introduced into the apparatus, the number of scintillations is found to diminish with increasing pressure of the air until the band has completely disappeared. This takes place at quite a low pressure of air, for example, for a pressure of about 1/4 mm. in the box.

The explanation of this result is obvious. The He_+ particles which escape from the mica occasionally collide with an atom of the gas in its path, and the electron which it captured in passing through the mica is removed. In such a case the He_+ becomes again an He_{++} particle, and the latter is twice as easily deflected in a magnetic field as the former. Suppose the collision occurs for the first time at the point P (Fig. 1). The particle after losing its electron travels along a new path shown in the figure, and the particle no longer strikes the part of the screen viewed by the microscope. It is found that the number of scintillations seen in the microscope falls off according to an exponential law as the pressure of the gas is raised. Such a result is to be expected, and from this data the average distance which the He_+ particle traverses before it loses its electron can be simply deduced. Certain small corrections are necessary to take into account the finite width of the band of scintillations as seen in the microscope, but we need not enter into details at this stage. It is convenient to express the mean free path λ_2 in air of the He_+ particles, not as the average length of path traversed in the rarefied gas before loss, but as the distance traversed in the same gas at standard pressure and temperature. For example, in a certain experiment, the mean free path in air of the particle was found to be 12 cm. at a pressure of 0·040 mm.; this corresponds to a mean free path of 0·0063 mm. at standard pressure and temperature.

In this way the mean free path in air before loss of an electron has been measured for different velocities, and it has been found over a considerable range that the mean free path varies directly as the velocity of the α-particle, so that the mean free path becomes shorter as the velocity of the α-particle diminishes. Since we may regard the loss of an electron from the singly charged particle as the result of a process of ionisation, such a relation is to be expected, and indeed, if we take into account the strong binding of a single electron by the He_{++} nucleus, the mean free path for loss is of the same order as that calculated from considerations of the number of ions per cm. produced by the α-particle in air and other gases. Comparisons have been made of the mean free path in air with that in hydrogen and helium. Its value is 4 to 5 times longer in hydrogen and more than 5 times longer in helium.

Now that the mean free path λ_2 is known, the value of λ_1 for capture can be deduced if the ratio N_2/N_1 is also known. A difficulty, however, arises at this point. In order to measure the ratio N_2/N_1 it is necessary that the active source should be covered with mica or other solid material. Gas cannot be used conveniently. It was found, however, that the ratio N_2/N_1 was the same within the limits of error whether the α-particles were reduced in velocity by passage through celluloid, mica, aluminium, or silver. For this purpose the mica was kept the same and a very thin sheet of the substance under examination spread over it. The thickness of the sheet was sufficient to set up a new equilibrium between the singly and doubly charged particles, but not sufficient to alter materially the velocity of the ionising rays.

Since the value of the ratio N_2/N_1 suffers no appreciable change for absorbers of such different atomic weights, we may safely conclude that the ratio for a

hypothetical sheet of solid air would be the same as for mica.

We have now all the data required to determine the values of λ_1 and λ_2 corresponding to α-particles of different velocities. The results are given in the following table for three different velocities. The mean free paths are expressed in terms of millimetres of air at standard pressure and temperature. V_0, the maximum velocity of the α-particles from radium C, is $1{\cdot}9 \times 10^9$ cm. per second.

Velocity V in terms of V_0.	$\lambda_2/\lambda_1 = N_2/N_1$ for Mica.	Mean Free Path λ_2 for Loss in Air.	Mean Free Path λ_1 for Capture in Air.
0·94	1/200	0·011 mm.	2·2 mm.
0·76	1/67	0·0078 mm.	0·52 mm.
0·47	1/7·5	0·0050 mm.	0·037 mm.

It has been seen that the mean free path for loss varies directly as the velocity, and thus only alters in a ratio of about 1 to 2 over the range of velocities given in the table. On the other hand, the ratio λ_2/λ_1 increases very rapidly with diminution of velocity varying approximately as V^{-5}. From this it follows that λ_1 varies as V^6, thus decreasing by a factor of 60 or more when the velocity is halved.

From these data and relations it can easily be calculated that the mean free path for capture should be equal to that for loss for a velocity about $0{\cdot}3\ V_0$, and for this speed the numbers of He_+ and He_{++} particles should be equal.

The actual value of the velocity for equality of the two types in a special experiment was found to be $0{\cdot}29\ V_0$, in good agreement with the calculated value. It is a difficult matter to determine the values of λ_1 and λ_2 for velocities less than $0{\cdot}3\ V_0$, for not only are the scintillations weak in intensity and difficult to count with accuracy, but also the issuing rays are very heterogeneous and no longer show well-defined edges on the high velocity side. It was, however, noted that the ratio N_2/N_1 rapidly increased below the velocity $0{\cdot}3\ V_0$.

We have so far dealt with the equilibrium between He_+ and He_{++} particles. It is clear, however, that similar considerations apply to the equilibrium between singly charged and neutral helium particles at low velocities of the α-particle. It was noted that the neutral particles appear prominently after the rays have passed through mica of 6 cm. stopping power, but no doubt they could be detected for still lower stopping power. These neutral particles, of course, produce scintillations, but of an intensity corresponding to an α-particle of low velocity. These neutral particles probably lose and regain an electron many times before they are stopped in the zinc sulphide or other absorbing material. This effect was shown by introducing gas at low pressure into the apparatus, when the scintillations due to the neutral particles diminished in number and ultimately vanished. The explanation of this is similar to that given for the disappearance of the He_+ band, for the neutral particles occasionally lose an electron in passing through the gas and are then deflected away from the zero position by the magnetic field.

It was estimated that the mean free path in air for conversion of neutral helium particles to singly charged particles was about 1/600 mm. No doubt this is an average for particles of very different velocities which may be present in the neutral band.

For the higher velocities we have to deal mainly with the interchange $He_{++} \rightleftarrows He_+$. For velocities less than $0{\cdot}5\ V_0$ the interchange $He_+ \rightleftarrows He_0$ also comes in and becomes all-important for velocities less than $0{\cdot}3\ V_0$. No doubt, as Henderson has shown, at still lower velocities most of the He_{++} particles disappear and the He_0 and He_+ particles predominate.

At these low velocities, counting scintillations becomes very difficult and uncertain, and the photographic method, as used by Henderson, is preferable. It will be a matter of very great interest to examine whether the relative numbers of the three types of particles alter when the α-particles are slowed down by passage through different materials. This side of the work is being attacked by Mr. Henderson in the University of Saskatchewan.

There is one very interesting point that may be considered here. It has been shown that these singly and doubly charged α-particles are always present after the α-rays have passed through mica or other absorber, but are there any singly charged particles present when α-particles escape from a wire coated with an infinitely thin deposit of active matter? This was first tested for a platinum wire coated with a deposit of radium B+C, by exposure to the radium emanation, when it was found that singly charged helium atoms were present in about the equilibrium ratio for this velocity. This was a rather surprising observation, but it was thought it might result from the fact that by the recoil from radium A the radium B particles penetrate some distance into the material of the wire. Under these conditions many of the α-particles expelled from radium C have to pass through a small but appreciable thickness of matter before escape from the wire and might thus capture electrons. This explanation seemed unlikely because the average distance penetrated by the recoil atom is only a minute fraction of the mean free path for capture at such high velocities of the α-particle. The experiment was tried with a nickel wire on which radium C had been deposited on

the surface by the well-known method of dipping the wire in a hot solution of radium C. In this case the difficulty due to recoil is absent, but the number of singly charged particles was the same as before.

It is very significant that the relative number of singly and doubly charged particles is about the equilibrium ratio to be expected when the wire, after being activated, is coated with an appreciable thickness of copper or other material. We can scarcely suppose that singly as well as doubly charged particles are actually liberated from the radioactive nucleus itself, for even if it be supposed that an α-particle with an attendant electron is expelled, the electron must be removed in escaping through the very powerful electric field close to the nucleus. It is much more probable that the doubly charged α-particle in passing through the dense distribution of electrons surrounding the radioactive nucleus occasionally captures an electron, and that the process of capture and loss goes on to some extent in escaping from the radioactive atom. This seems at first sight rather unlikely when we consider the relatively large number of atoms an α-particle ordinarily passes through before equilibrium between capture and loss is established, but it is well known that the chance of effective electronic collisions appears in general to be greater for a charged particle expelled from the central nucleus than for a similar particle passing from outside through the electronic distribution of an atom. It may be that those electrons, the orbital motion of which round the nucleus is comparable with the speed of the α-particle, are particularly effective in causing capture or loss.

So far we have dealt mainly with the distribution in a magnetic field of the particles in a vacuum after their escape from a mica surface. Some very interesting points arise when the distribution is examined in the presence of sufficient gas to cause a rapid interchange of capture and loss along the path of the α-particle in the gas. This is best illustrated by a diagram, Fig. 4, in which the results are given for α-particles escaping through mica with a maximum emergent range of about 4 or 5 millimetres in air. Curves A and B give approximately to scale the distribution of He_+ and He_{++} particles in a vacuum, while C gives the relative number of neutral particles under the experimental conditions. Suppose now sufficient air is introduced into the vessel to cause many captures along the gas but yet not enough to reduce seriously the velocity of the α-particles. The first salient fact to notice is that the distributions A, B, C vanish and there remains a distribution of particles (curve D) about midway between A and B. This band is narrower than either A or C, and its height at the maximum much greater than either. It is evident that the particles have been compressed into a band of much narrower width than the normal distribution in curve B.

This is exactly what we should expect to happen. The swifter particles present suffer less capture than the slow; consequently the average charge of the swifter α-particles along the gas is less than $2e$, and their deflexion is less than the swiftest particles shown in curve B. On the other hand, the slower α-particles have an average charge nearer $1e$ than $2e$ and are relatively still less deflected than the swifter particles. It is thus clear that the resulting distribution of particles with air inside the vessel will be concentrated over a much narrower width than the main band of He_{++} particles. From calculation based on the laws of capture and loss, the width of the band under the experimental conditions can be deduced and is found to be in good accord with experiment. It will be seen to be significant that similar results have been observed for hydrogen under corresponding conditions.

General Discussion of Results.

Attention may now be devoted to a consideration of the results so far obtained and the possibility of their explanation on present views. In the first place, it is important to emphasise the large number of capture and losses that occur during the flight of an α-particle from radium C. While the mean free path of the α-particle from radium C of 7 cm. range is about 3 mm. in air, its value rapidly decreases with lowering of the velocity of the α-particle and is probably about 0·0015 mm. for a velocity of 0·3 V_0. It is not difficult to calculate that not far short of a thousand interchanges of charge occur during the path in air of a single particle between velocities V_0 and 0·3 V_0. While the data so far obtained do not allow us to calculate the number of interchanges of charge that occur between velocities 0·3 V_0 and 0, it seems probable that the number is considerably greater than a thousand. We have already pointed out that for low velocities the interchange $He_+ \rightleftarrows He_0$ predominates. When we consider the rapidity of interchange of charges of the α-particle at average velocities, it seems clear that we cannot expect to observe any appreciable difference in power of penetration between a beam of rays of the same velocity, whether consisting initially of singly or doubly charged particles. It is clear that a singly charged particle after penetrating a short distance is converted into a doubly charged particle and *vice versa*, and that the effects due to the two beams should be indistinguishable. Henderson tried such absorption experiments, using the photographic method, but with indefinite results.

When an α-particle captures an electron, the latter presumably falls into the same orbit round the helium nucleus as that which characterises an ionised helium atom, *i.e.* an atom which has lost one electron. When the α-particle with its attendant electron passes swiftly through the atoms of the gas in its path, it will not only ionise the gas but will also occasionally be itself ionised, *i.e.* will lose its attendant electron. When we take into account the strong binding of the first electron to the helium nucleus—ionisation potential about 54 volts—the mean free path for loss of the captured electrons in air is of the right order of magnitude to be expected from considerations based on the ionisation by the α-particle per unit path in air. While we can thus offer a quantitative explanation of the mean free path for loss observed experimentally, the inverse problem of the capture of an electron by the flying α-particle presents very great difficulties.

In the actual case, the α-particle is shot at high speed through gas molecules which for all practical purposes may be supposed to be at rest. For convenience of discussion, however, it is preferable to make an equivalent assumption, namely, that the α-particle is at rest and

the gas molecules stream by it with a velocity equal and opposite to that of the α-particle. Now the maximum velocity of an α-particle from radium C is equivalent to that gained by an electron in falling freely between a difference of potential of about 1000 volts; so that the electrons comprising the molecules of air or other gas have a velocity of translation numerically equal to this. For brevity, it is very convenient to speak of this velocity or energy as that due to a "1000-volt" electron.

When the electrons in an atom pass close to the α-particle, one of them may be removed from the parent atom by the collision, energy being required for this process. The ionisation potential for oxygen or nitrogen is about 17 volts, which is a very small quantity compared with the energy of translation of a 1000-volt electron.

If we consider the forces involved between an α-particle and moving electron as of the ordinary electrostatic type, the electron will describe a hyperbolic orbit round the nucleus, the angle of deflexion of the path of the electron resulting from the collision depending on the nearness of approach of the electron to the nucleus. On ordinary dynamics, the electron will never be captured in such a collision if there is no loss of energy by radiation. If capture for some reason results from the collision, it means that an amount of energy corresponding to at least a 1000-volt electron has in some way been got rid of. This loss of energy may be supposed to be due to some interaction between the α-particle and colliding nucleus with its attendant electrons, or to the loss of energy by radiation during the collision. The first supposition seems at first sight plausible, for we know that the innermost electrons of oxygen or nitrogen are strongly bound and require energy of the order of 500 volts to remove them from the atom. But there is one very strong and, it seems to me, insuperable objection to this view.

I have found that the deflexion in a magnetic field of a pencil of α-particles passing through a suitable pressure of hydrogen is similar to that shown in curve Fig. 4 for air. This shows that the α-particle passing through hydrogen captures electrons of energy about 120 volts to about the same degree as in air. Now we know that the electrons in the hydrogen atom or molecule are lightly bound, and an energy of not more than a 30-volt electron, suitably applied, would entirely separate the component nuclei and electrons in the hydrogen molecule. In the case of hydrogen, therefore, we cannot hope to account for the requisite loss of energy, which for the experiment considered is about 100 volts. If these experiments with hydrogen are correct, and are valid for all velocities of the α-particle, we are driven to conclude either, that some unknown factors are involved in the capture, or that the loss of energy of the electron must be ascribed to radiation. In such a case, capture of an electron may be regarded as the converse of the photo-electric effect, where radiation falls on matter and swift electrons are ejected from the matter. In the case under consideration, swift electrons are shot towards a charged nucleus and an occasional electron is captured with the emission of energy in the form of radiation. On such an hypothesis the radiation of energy from an α-particle passing through a gas due to the frequency of capture is very great, amounting to about 3 per cent. of the total energy of the α-particle. This seems to be an unexpectedly large amount, but cannot be ruled out as impossible in the present state of our knowledge.

In the discussion of this very thorny question, I have confined myself mainly to the case of capture by the swift α-particle, where the difficulties of explanation are much greater than for capture at slower velocities. Our information is at present too incomplete to give a decisive answer, but there seems to be no doubt that the unexpected frequency of capture of electrons by swift α-particles raises many new and interesting questions of the nature of the processes that can occur in collisions between electrons and matter.

I need scarcely say that the phenomena of capture and loss are not confined to the α-particle, but are shown by all charged atoms in swift motion through a gas, and were long ago observed in the case of positive rays. On account, however, of the high velocity of the α-particles and the ease of their individual detection, the process of capture and loss can be studied quantitatively under simpler and more definite conditions than in the case of the electric discharge through a gas at low pressure.

On this occasion I have devoted my attention to the most recent additions to our knowledge of the life history of the α-particle. This knowledge has been obtained from the study of the rapid interchange of charges when an α-particle passes through matter. I have only incidentally referred to the numerous collisions with electrons along the track of the α-particle which result in dense ionisation. I have omitted any consideration of those rare but interesting encounters in which an α-particle is deflected through a large angle by a close collision with a nucleus. I have omitted, too, the still rarer encounters which may result in a disintegration of an atomic nucleus like that of nitrogen or of aluminium. We have seen that an α-particle has an interesting history. Usually it is retained as an integral and orderly part of a radioactive nucleus for an interval of more than a thousand million years. Then follows a cataclysm in the radioactive nucleus; the α-particle gains its freedom and lives an independent life of about one hundred millionth of a second, during which all the incidents referred to in this lecture occur.

If we are dealing with a dense and compact uranium or thorium mineral, the α-particle after acquiring two electrons and becoming a neutral helium atom may be imprisoned in the mineral as long as the mineral exists. The occluded helium can be released from the mineral by the action of high temperature, and after removal of all other gases can be made to show its presence by the characteristic brilliant luminosity under the stimulus of the electric discharge. In the circumstances of such an experiment, only small quantities of helium are liberated. Large quantities of helium, sufficient to fill a large airship, have, however, been isolated from the natural gases which escape so freely from the earth in various parts of Canada and the United States. It is a striking fact that every single atom of this material has in all probability had the life history here described.

Addendum.[1]

It may be of interest to give here a brief review of some additional facts in connexion with the α-particle, brought to light in recent years. It has long been known that α-particles, although projected from the source at the same speed, travel unequal distances through a gas. For example, the maximum distance travelled by the α-particles from radium C in air is 7·04 cm. at 760 mm. and 15° C., the minimum distance is about 6·4 cm., and the mean distance about 6·8 cm. Some "straggling" of the α-particles is to be anticipated on general grounds, since the α-particle loses its energy mainly in liberating electrons from the atoms of matter in its path. On the laws of probability, one α-particle may meet more atoms and liberate more electrons than another, and thus lose energy at a faster rate. The amount of straggling observed is, however, much greater than can be accounted for in this way, and the occasional large deflexions of the α-particles due to nuclear collisions are so rare, except near the end of the range, that they do not seriously influence the final distribution.

Henderson has suggested that the property of an α-particle of capturing and losing electrons will introduce a new factor in causing straggling. No doubt this is the case, but the rates of capture and loss observed appear to be too rapid to account entirely for the discrepancy between theory and experiment. Another interesting suggestion has been made by Kapitza to account for the magnitude of this straggling. From the experiments of Chadwick and Bieler on the collision between α-particles and hydrogen nuclei, it has been deduced that the α-particle or helium nucleus has an asymmetrical field of force around it. This asymmetry of the electric field must become small at the distance of the orbits of the electrons in the neutral helium atom, but may be sufficient to fix the plane of the orbit of an electron relative to the axis of the helium nucleus.

Suppose that the α-particles liberated from a radioactive source have their axis orientated at random, and that the direction of the axis of each individual particle remains unchanged during its motion. In some cases, for example, the captured electron will describe an orbit of which the plane is nearly in the direction of motion of the α-particle; in other cases nearly perpendicular to it. It is to be expected, however, that the chance of losing the captured electron by collision will be greater in one case than the other; or, in other words, the mean free path of the singly charged α-particle before loss of its electron will be different in the two cases.

On this view, it is to be anticipated that one group of α-particles will lose energy faster than the other, and the ranges will be different. In order to test whether α-particles show the individual differences to be expected on this theory, Kapitza has photographed in the Cavendish Laboratory the tracks of a number of α-particles by the Wilson expansion method, using a strong magnetic field of about 70,000 Gauss, produced by a momentary current of great intensity. The magnetic field was sufficiently strong to cause a marked bending of the track of the α-particle. It was found that the curvature of the tracks at equal distances from the ends showed marked variations. Before any definite decision can be reached, a large number of tracks obtained in this way must be carefully measured up and allowance made for the sudden bends which occur due to a nuclear collision with the atoms of nitrogen or oxygen. The frequency of these bends near the end of the range complicates the interpretation of the apparent curvature which is measured. The experiments, which are still in progress, are difficult and require great technical skill, and it will be a matter of much interest if any definite asymmetry in the orbits of the singly charged α-particles can be established by this or other methods. If such an asymmetry exists, it must influence to a small extent the arrangement of the two electrons round the helium nucleus and possibly their spectrum.

During the past two years, Blackett, in the Cavendish Laboratory, has made a careful examination of the frequency of occurrence of sharp bends or forks in the tracks of α-particles near the end of their range in air and other gases. For this purpose, a simple form of Wilson expansion chamber, of the type designed by Shimizu, has been used, and each track has been photographed in two directions at right angles to each other to fix the angle of the forks in space. A large number of photographs have been taken, and the frequency of the forks has been examined in different gases, particularly in the last centimetre of the range of the α-particle. Assuming that these forks arise from nuclear collisions, it is possible to deduce from the experimental data the variation of velocity of the α-particle near the end of its range. It is known from the work of Geiger and Marsden that the maximum velocity v of the α-particles of emergent range R is given by $v^3 \propto R$, when R is not less than one centimetre. Blackett finds that this relation between velocity and range no longer holds near the end of the track but is replaced by a relation of the form $v^{1\cdot5} \propto R$.

In the course of these experiments a number of well-defined forks have been photographed in hydrogen, helium, air, and argon by Blackett, and also by Auger and Perrin in Paris. By measuring the angles between the original direction of the α-particle and the direction of the colliding particles after collision, the accuracy of the laws of impact can be directly tested. The results are found, within experimental error, to be in agreement with the view that the impacts are perfectly elastic and that the conservation of energy and of momentum hold in these nuclear collisions. Conversely, by assuming that the impacts are perfectly elastic, it is possible to deduce the mass of the recoil atom in terms of the α-particle of mass 4·00. For example, a fork in helium gave the mass of the recoil atom 4·03, and a fork in hydrogen gave the mass of the recoil atom 1·024. In a collision between the α-particle and a helium nucleus the angle between the forks should be exactly a right angle; the value measured was 89° 45′.

[1] This did not form part of the Royal Institution discourse, but it may usefully supplement one or two of the points surveyed in that lecture.

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The Revolt against the Teaching of Evolution in the United States.

THE movement in some of the Southern and Western United States to suppress the teaching of evolution in schools and universities is an interesting and somewhat disconcerting phenomenon. As it was I who, all unwittingly, dropped the spark which started the fire, I welcome the invitation of the Editor of NATURE to comment on the consequences.

First as to my personal share in the matter. At the Toronto meeting of the American Association I was addressing a scientific gathering, mainly professional. The opportunity was unique inasmuch as the audience included most of the American geneticists, a body several hundreds strong, who have advanced that science with such extraordinary success. I therefore took occasion to emphasise the fact that though no one doubts the truth of evolution, we have as yet no satisfactory account of that particular part of the theory which is concerned with the origin of *species* in the strict sense. The purpose of my address was to urge my colleagues to bear this part of the problem constantly in mind, for to them the best chances of a solution are likely to occur. This theme was of course highly academic and technical. Nevertheless, to guard against misrepresentation, I added the following paragraph by the advice of a friend whose judgment proved sound, though to me such an addition looked superfluous.

"I have put before you very frankly the considerations which have made us agnostic as to the actual mode and processes of evolution. When such confessions are made the enemies of science see their chance. If we cannot declare here and now how species arose, they will obligingly offer us the solutions with which obscurantism is satisfied. Let us then proclaim in precise and unmistakable language that our faith in evolution is unshaken. Every available line of argument converges on this inevitable conclusion. The obscurantist has nothing to suggest which is worth a moment's attention. The difficulties which weigh upon the professional biologist need not trouble the layman. Our doubts are not as to the reality or truth of evolution, but as to the origin of *species*, a technical, almost domestic, problem. Any day that mystery may be solved. The discoveries of the last twenty-five years enable us for the first time to discuss these questions intelligently and on a basis of fact. That synthesis will follow on analysis, we do not and cannot doubt."

The season must have been a dull one, for upon this rather cold scent the more noisy newspapers went off full cry, with scare-headings "Darwin Downed," and the like.

All this seemed foolish enough, and that practical consequences would follow was not to be expected. Nevertheless, Mr. William Jennings Bryan, with a profound knowledge of the electoral heart, saw that something could be made of it and introduced the topic into his campaign, which, though so far harmless in the great cities, has worked on the minds of simpler communities. In Kentucky a bill for suppressing all evolutionary teaching passed the House of Representatives, and was only rejected, I believe, by one vote, in the Senate of that State. In Arkansas the lower house passed a bill to the same effect almost without opposition, but the Senate threw it out. Oklahoma followed a similar course. In Florida, the House of Representatives has passed, by a two-thirds vote, a resolution forbidding any instructor "to teach or permit to be taught Atheism, agnosticism, Darwinism, or any other hypothesis that links man in blood relation to any form of life." This resolution was lately expected to pass the Senate. A melancholy case has been brought to my notice of a teacher in New Mexico who has been actually dismissed from his appointment for teaching evolution. This is said to have been done at the instigation of a revivalist who visited the district, selling Mr. Bryan's book.

The chief interest of these proceedings lies in the indications they give of what is to be expected from a genuine democracy which has thrown off authority and has begun to judge for itself on questions beyond its mental range. Those who have the capacity, let alone the knowledge and the leisure, to form independent judgments on such subjects have never been more than a mere fraction of any population. We have been passing through a period in which, for reasons not altogether clear, this numerically insignificant fraction has been able to impose its authority on the primitive crowds by whom it is surrounded. There are signs that we may be soon about to see the consequences of the recognition of "equal rights," in a public recrudescence of earlier views. In Great Britain, for example, we may witness before long the results which overtake a democracy unable to tolerate the Vaccination Act, and protecting only some 38 per cent of its children.

As men of science we are happily not concerned to consider whether a return to Nature, as a policy, will make for collective happiness or not. Nor is it, perhaps, of prime importance that the people of Kentucky or even of "Main Street" should be rightly instructed in evolutionary philosophy. Mr. Bryan may have been quite right in telling them that it was better to know "Rock of Ages" than the ages of rocks. If we are allowed to gratify our abnormal instincts in the search for natural truth, we must be content, and we may be thankful if we are not all hanged like the Clerk of Chatham, with our ink-horns about our necks.

For the present we in Europe are fairly safe. A brief outbreak on the part of ecclesiastical authority did follow the publication of the "Origin of Species," but that is now perceived to have been a mistake. The convictions of the masses may be trusted to remain in essentials what they have always been; and I suppose that if science were to declare to-morrow that man descends from slugs or from centipedes, no episcopal lawn would be ruffled here. Unfortunately the American incidents suggest that our destinies may not much longer remain in the hands of that exalted tribunal, and that trouble may not be so far off as we have supposed.

W. BATESON.

The Unity of Anthropology.

Die Kultur der Gegenwart: ihre Entwicklung und ihre Ziele. Herausgegeben von Paul Hinneberg. Dritter Teil: Mathematik, Naturwissenschaften, Medizin. Fünfte Abteilung: Anthropologie. Unter Leitung von G. Schwalbe und E. Fischer. Pp. viii + 684 + 29 Tafeln. (Leipzig und Berlin: B. G. Teubner, 1923). *22s. 7d.*; cloth, *27s. 4d.*

ANTHROPOLOGY, the science of man—a proud name indeed! But, alas, there is little at present but the name which stands for the unity of this science. Its subject matter it has to share with anatomy, biology, theories of heredity and variation, geology, sociology, and social psychology. Its methods are borrowed from several natural and humanistic sciences. Its aim and scope seem at first but arbitrarily claimed and loosely circumscribed by man's excessive conceit about his own importance as a central object of study. After all, man is physically but one animal species among others, while his soul has been for a long time already in the keeping of another science—that of psychology.

The unfortunate fact is that man has been created with a body and a soul as well, and this original sin, after having incessantly haunted the reflective mind through myth, religion, theology, and metaphysics, comes now to lay its curse on anthropology. Physical and cultural anthropology are divided by the deep rent between soul and body, matter and mind, which is no easier to bridge over in science than in the somewhat looser speculations which precede it.

An anthropologist has to be a Jack-of-all-trades as matters now are, however much he may deplore it, and he needs a good handbook of his science, wherein to store that part of his stock in trade which is not kept fresh by constant handling in his own specialist's

workshop. Until the appearance of the present volume there was no satisfactory manual covering the whole field, or rather the several plots embraced by the name Anthropology. In a science where real unity is impossible, no one can specialise in all its branches. Collaboration is the only way of dealing with each subject in an adequate manner; and no better or more competent collaborators could be found than the six German savants whose names figure here on the title-page.

The handbook is the fifth part of the section devoted to natural science in the monumental series which is being published under the title "Die Kultur der Gegenwart" by B. G. Teubner, and aims at an exhaustive statement of the present state of knowledge. It commands real admiration to see how this extremely ambitious, yet thoroughly adequate, scheme is being carried out, in spite of the interruption caused by the War, in spite of the hard economic struggle which the academic classes in Germany have to face, in spite of the critical state of the publishing trade in that country.

There is first in this volume a short introductory chapter by Prof. E. Fischer, giving a systematic initiation into the subject, a clearing up and ordering of the field, so dear to the methodical mind of the German, and, to tell the truth, so extremely important and useful in a manual. In this case, the introduction is written with a strong somatological bias, and treats the cultural side of our science in a rather stepmotherly manner. The history of anthropology, for example, contains no reference to any of the great pioneers of cultural anthropology; the names of Bastian, Tylor, Frazer, Durkheim are not even mentioned. On the whole, it is the least satisfactory section of the book. There follow four parts exclusively devoted to physical anthropology: Part II., on Measurements, by Prof. Th. Mollison; Part III., Somatology, by Prof. E. Fischer and Th. Mollison; Part IV., the Human Races, by Prof. Fischer; Part V., the Theory of Human Descent, by the late Prof. G. Schwalbe. These parts are all one could wish for—clear, concise, up-to-date, exhaustive. The next part is an account of prehistoric anthropology by the late Prof. M. Hoernes. This part is naturally divided between the fields of physical and cultural anthropology. Only the last two of the eight essays belong entirely to the other—to the social, or cultural aspect of anthropology. Of these the one is an account of ethnology, by Dr. F. Graebner. The other, entitled "Sozialanthropologie," and written by Prof. A. Ploetz, is a very suggestive but as yet only tentative attempt at a correlation of race with cultural achievement, an attempt to construct a theory of the organising and civilising values of each of the several varieties of mankind.

Two of these essays will be of special interest, for they are not only the last word of science on the subject of pre-history and theory of descent, but they are also the last contribution of two very eminent scholars, Prof. Hoernes and Prof. Schwalbe, both of whom died while the book was in the publisher's hands.

On the whole, the volume will be of great use as a handbook specially to the social anthropologist—using this word in the English sense—just because the physical branches have been worked out at a greater length and in a more final and authoritative manner. Now naturally, if you are an anthropologist specialised in a corner of your field, you need to have the other plots well mapped out. In your own little plot you ought to find your way without a map!

Nor is it possible in the present state of cultural anthropology to give a final and entirely impartial statement of its results. For its methods, its aim, and its subject matter are in a flux, and there is very little agreement even on points of fundamental importance. As is well known, the value of the old evolutionary theories is being vigorously contested, while there is a great deal of dissension and confusion about the place of "psychological," "historical," and "sociological" explanations. Dr. Graebner is one of the pioneers of the "historical" school and its ablest exponent in Germany. This school concentrates its attention on the analysis of "cultural complexes," on the diffusion of institutions, customs, and cultural objects, and on the mechanism of culture-contact.

Many anthropologists in Great Britain will no doubt be interested in Dr. Graebner's essay—both those who wish to see perhaps the most exhaustive account of their own point of view extant, and those who wish to have a clear statement for criticism.

Dr. Graebner states his case in an introductory discussion of the aims of ethnology (pp. 445-447) and in a final summing up (pp. 572-583). The body of the essay contains first the analysis of the various cultures of humanity—savage, barbarous, and civilised. In the second main section there is an account of the evolution of the various elements of culture—clothing and ornaments, housing, economics, technology, trade and communication, social organisation, art and knowledge. This part is extremely interesting, for it shows very forcibly how fruitful and interesting evolutionary theories can be when based on a conception of humanity, divided into a number of cultural types and not lumped together into one homogeneous whole. Dr. Graebner's essay might go very far towards the clearing up of misunderstandings, convincing the intransigent opponents of the historical school, and, last though not least, towards the levelling up of the sharp rift which now divides the cultural and evolutionary schools in England, Germany, and the United States.

The essay, it seems, was practically finished before the War, and this explains why the work of Dr. Rivers finds only a subordinate place, while the still more radical and extremely interesting theories of Prof. Elliot Smith and Mr. Perry are not even mentioned. The work of Prof. A. R. Brown of Cape Town on the Andaman Islanders, easily the best contribution of the youngest generation of field anthropologists and very important in its bearing on the Negrito culture, came out too late to be considered. Had Dr. Graebner been able to incorporate the views of these scholars in his essay, this would have become of still greater value to modern ethnology.

Returning now to the question raised at the outset, that, namely, of the unity of anthropology, it is clear that this work reflects the present state of affairs as well as the prevalent tendencies : a deep rent between the physical and cultural branches ; a preponderance given to the physical ones ; and, within the cultural branches, an attitude of hostility to psychology and evolution.

On these lines, however, anthropology certainly will never attain its desired unity. For, first of all, so-called physical anthropology is not a new science or a new method or a new point of view. " We have to regard anthropology as nothing else but a comparative anatomy of man " (Prof. Schwalbe, p. 227). Nor is it easy to see how and where such comparative anatomy can establish any direct connexion with the study of human culture, or help in the understanding of social organisation, custom, and tradition. The only point where cultural anthropology needs the assistance of the naturalist is in the classification of the several varieties of mankind. Even here, comparative anatomy has already given us apparently all it could, which has been of great value indeed. But now, it is from biology, mainly from theories of natural selection, variation, and Mendelism, that we can hope for effective contributions to progress. Thus physical anthropology is not a new or independent science, but the application of several natural studies to the problem of varieties of man. Nor can physical anthropology ever be capable of throwing light on the relevance of these varieties. For a human race does not interest us as a mere class of animals, but only in so far as it is a substratum for a definite type of civilisation.

The study of civilisation—" cultural " or " social " or " psychological anthropology "—is the only science which can take the lead in the organising of anthropological problems, for it studies that which is of primary interest to us in Man : his mind, his creative power, and his social tradition. Cultural anthropology is, moreover, an entirely new branch of learning. Its field-work, the observations on the customs, social organisation, and mentality of natives, must be done by specialists possessing certain particular aptitudes as well as an appropriate training. The theory of cultural anthropology has also to elaborate its own methods, which it can borrow from nowhere else and share with no other study.

An empirical proof of this far wider scope of cultural as against physical anthropology can be found in the history of modern field-work and theory. Sir Baldwin Spencer, a distinguished zoologist who took up field-work late in life, was gradually drawn into exclusively social and cultural studies, and in his latter researches did not trouble about any measurements or somatological observations, while he concentrated exclusively on his remarkable researches into the ideas and institutions of the Australian aborigines. Dr. Rivers, a neurologist, physiologist, and medical man, who in his earlier field-work still made some anatomical and physiological observations, gave them up entirely, as irrelevant, in his latter explorations in Melanesia, in which he has created a new type of cultural research. In the work of Dr. Haddon and Prof. Seligman, again one a zoologist and the other a medical man, physical anthropology plays an entirely subordinate part, although neither of them has given up somatology altogether. Again in theory, we see how a distinguished anatomist, Professor Elliot Smith, who became interested in ethnology through anatomical observations, has been drawn, in his ethnological work, entirely into sociological, cultural, and psychological research.

Not that cultural anthropology should ever become independent of the naturalist's help or give up its foundations of zoological science. Only it appears that it will have to turn to the study of life and function rather than that of bones, muscles, and structure. The biometrical line of research, the work done by the Eugenic Society, the applications of Mendelism to anthropology seem all to be symptoms and promises of extremely interesting results to follow. It is undoubtedly a pity that some of the results already obtained by these studies could not be incorporated in this manual. They certainly indicate much more promising and important lines of junction between the theory of organic nature and that of culture than those on which was based the old loveless and sterile marriage between anatomical description and psychological guesswork. For the psychology which is needed in modern anthropology is no more the old associationist and introspective empiricism, but biological psychology founded on a comparative study of instinct and largely inspired by the study of animal behaviour, the child's development, mental disorders, the analysis of dreams and of the structure of language.

In all these applications, the guiding and selecting initiative must come from the direct study of culture. On these lines and on these lines only the new anthropology can hope to ripen in the future to an independent, self-contained, and sovereign study with a firm basis in biological science, itself a solid bridge between humanism and natural history. But this is only a hope and a forecast! Much work will have to be done yet, and in this, the present volume, an excellent summary of the actual state of our science will be of great help and value.

B. Malinowski.

Sexual Physiology.

The Physiology of Reproduction. By Dr. Francis H. A. Marshall. Second and revised edition. Pp. xvi + 770. (London: Longmans, Green and Co., 1922.) 36*s.* net.

With the gradual rise of the experimental school in biology, and with the increasing demand for scientific method in veterinary and medical practice, the existence of a definite gap in scientific literature came to be recognised. Nowhere was the subject of the physiology of reproduction dealt with at all adequately; in the ordinary text-book of physiology it was dismissed after a very superficial treatment. Moreover, there was not a physiologist competent to write upon this subject at all authoritatively. Biologists, pure and applied, owe a great debt of gratitude to Dr. Marshall for having chosen this field in which to work; for, thanks to his labours, the difficulties of a great band of research workers have been made much less complex.

The second edition of this comprehensive text-book on sexual physiology maintains the reputation so readily secured by its predecessor, published thirteen years ago and long since out of print. It is born into a world somewhat different from that in which the first edition played its part so well; the specialities have become so fragmented that to-day no one book on this subject can hope to satisfy the demands of such varied interests as those of the experimental biologist, the cytologist, the embryologist, the psychologist, the geneticist, the veterinarian, the obstetrician, and the eugenist. Each no doubt will discover disappointing omissions and conclude that his own particular interest has been somewhat neglected; yet it cannot be denied that the book remains the only common meeting-ground for all those who are working on the general subject of the physiology of reproduction. It is a most admirable book of reference for the specialist in one branch who wishes to examine his conclusions in the light of the work of others, while to the student of biology at the beginning of his career it will prove a veritable mine of information and a great stimulus to his scientific curiosity, for in its pages a hundred and one problems, all urgently demanding further investigation, are suggested. When it is remembered that Dr. Marshall reviews the work of some fourteen hundred investigators, that for the exposition of the subject-matter nearly eight hundred pages are required, and that for the making of the book the collaboration of four specialists was demanded, an idea of the immense amount of research that has been and is being done in this most important subject will be gained.

Dr. Marshall himself is responsible for the chapters dealing with the breeding season, the œstrous cycle, the œstrous changes in the non-pregnant uterus and in the ovary, gametogenesis, the accessory sexual apparatus, the endocrine function of the gonads, parturition, lactation, fertility, sex-determination, and the phases in the life of the individual. Dr. Cramer has revised and partly rewritten his section on the biochemistry of the sexual organs, and has also revised that originally contributed by Dr. Lochhead on the changes in the maternal organism during pregnancy. Dr. Lochhead's other sections on fœtal nutrition and on the physiology of the placenta, owing to the author's absence from Great Britain, unfortunately have not been revised.

The least satisfactory part of the book, both as regards arrangement and subject-matter, is, we think, that contributed by Dr. Cresswell Shearer on fertilisation. It begins with a section on the oxidation processes in the ovum on fertilisation and during development; it concludes with one on parthenogenesis, natural and artificial, in which the actual processes which initiate cleavage are discussed; while between the two we find, *inter alia*, under "The hereditary effects of fertilisation" a quite unnecessary statement of Weissmann's speculations grafted gratuitously on to an elementary exposition of Mendelism. In this the author, apparently through an inadequate comprehension of the chromosome hypothesis, devotes a considerable amount of space to tilting at windmills of his own creation without attempting to initiate the reader into the actual facts which have been demonstrated by Morgan and his school. Surely, if it was not the author's purpose to deal with experimental genetics, it would have been better to have omitted all reference to the subject than to have detailed a nomenclature which is of historical interest only and to have criticised hypotheses of which the significant data are not mentioned. But, as we have said, no specialist will find his own peculiar interest satisfactorily treated in this book: the obstetrician will complain that the phenomena connected with the function of reproduction in the human subject do not meet with the treatment that they deserve, the psychologist will perhaps disagree with

Dr. Marshall's choice of his authorities in this particular field, but each must remember that this book has been written not for one interest but for all that are concerned with the physiology of reproduction.

As it stands, the book is the best treatise on the subject that we have, and it is because it is so good and so valuable that its beneficiaries are so concerned in its further development. It must remain the best book on the subject and a memorable contribution to British scientific literature. F. A. E. C.

Applied Organic Chemistry and International Trade.

(1) *Synthetic Colouring Matters: Vat Colours.* By Prof. Jocelyn Field Thorpe and Dr. Christopher Kelk Ingold. (Monographs on Industrial Chemistry.) Pp. xvi+491. (London: Longmans, Green and Co., 1923.) 16*s*. net.

(2) *Dyes and their Application to Textile Fabrics.* By A. J. Hall. (Pitman's Common Commodities and Industries.) Pp. ix+118. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 3*s*. net.

(3) *Handbuch der biologischen Arbeitsmethoden.* Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 84. Abt. I: *Chemische Methoden.* Teil 10, Heft 3: *Spezielle chemische Methoden. Harze und Pflanzenfarbstoffe.* Pp. 585-832+xxii. (Berlin und Wien: Urban und Schwarzenberg, 1922.) 10.5 Schw. francs.

DURING the period which has elapsed since the Armistice, events in the domain of international trade confirm the belief engendered by the War that the manufactures based on applications of organic chemistry are among the most important of our key industries. The pre-War dependence on German sources for the supply of fine chemicals was a national menace, which has since been largely obviated by the creation of a new industry in organic chemicals entirely unprecedented in the annals of the British Empire. A remarkable achievement standing to the credit of the manufacturers of synthetic dyes and intermediates may be appreciated by the circumstance that whereas in 1914 eighty per cent. of these colours used in Great Britain were of German origin and only twenty per cent. of home production, nowadays these proportions are reversed, British makers accounting for eighty per cent. of the total supply, the remainder coming from abroad, and at present more from Switzerland than from Germany.

In regard to certain complicated colours, such as the vat dyes, now being produced for the first time in Great Britain, it is generally admitted by dye users that the quality is well up to continental standards, but a difficulty arises in the matter of cost of production. Owing to the disparity between the exchanges this cost is far lower in Germany than in Great Britain. A vat dye put on the market by British makers at four or five shillings per pound can be sold with profit for the same number of pence by the German producers. It should be obvious that without the partial protection afforded by the Dyestuffs Act the British manufacturers must get the worst of this unfair competition. The closing down of our newly established works in dyes and intermediates would, however, mean "Never again" in a sense very different from that in which this patriotic exclamation was uttered in 1914. The value of a home supply of dyes has already been clearly demonstrated since the French and Belgian occupation of the Ruhr rendered very uncertain the importation of German colours even under licence.

(1) The monograph on vat colours by Prof. Thorpe and Dr. Ingold deals with an important group of dyes which are among the most durable and brilliant of colouring matters. This group includes not only the long-known dyes, indigo and Tyrian purple, but also several series of new colours discovered during the present century. These dyes have highly complicated chemical structures and are produced by difficult operations taxing to the utmost the skill and ingenuity of scientifically trained industrialists. It is noteworthy that vat dyes are now being manufactured by at least three British firms, and the chemists engaged in this industry have not only copied very successfully the German types, but also have placed on the market several entirely new and valuable vat colours. The monograph now under review, which arrives at a crucial time in the history of British chemical industry, is the first English treatise dealing with this intricate group of synthetic dyes.

(2) Mr. Hall's handbook, which is one of a series dealing with common commodities and industries, is written for the non-technical reader and is intended to give him a comprehensive view of the dye and dyeing industries. In an outline of the development of the dye industry it is significant to note the opening sentence of the first letter which ever passed between a dye user and a synthetic dye maker. Messrs. Pullar, writing to the discoverer of mauveine in 1856, stated, "If your discovery does not make the goods too expensive it is decidedly one of the most valuable that has come out for a very long time." This matter of cost is still a burning question between makers and users, and the presence in allied and neutral countries of parcels of dirt-cheap German dyes tends to make our dyers and printers chafe against the restrictions imposed under the Dyestuffs Act. But since the principal Rhenish dye factories are within the allied spheres of occupation, it should not be impossible to make fiscal arrangements

whereby this fraudulent undercutting could be prevented.

(3) The researches on synthetic dyes have not engrossed the attention of continental chemists to the exclusion of the study of natural colouring matters, and the present monograph, well printed on paper of pre-War quality, is a good indication of the interest taken by Swiss chemists in the border-line science of biochemistry. The subjects dealt with include a summary of the methods employed in obtaining balsams and resins and in subjecting these materials to systematic decompositions. The appropriate methods of proximate analysis are also indicated. The larger section of the work is devoted to the identification and preparation of the most important vegetable colouring matters. The detailed information supplied on this abstruse subject is supplemented by many references to original memoirs, and there is an adequate index. The brochure is the eighty-fourth section of the comprehensive handbook of experimental methods in biology being issued under the editorship of Dr. Emil Abderhalden, the well-known physiologist.

Relativity Problems.

Sidelights on Relativity. By Prof. A. Einstein. I. Ether and Relativity. II. Geometry and Experience. Translated by Dr. G. B. Jeffery and Dr. W. Perrett. Pp. iv+56. (London: Methuen and Co., Ltd., 1922). 3*s.* 6*d.* net.

PARTICULARLY since the introduction of the theory of relativity, the problem of the ether has been a bone of contention among physicists. They have been divided into two camps; one unwilling to let go the idea of an ether, though perhaps in modified form, and the other seeing in the theory of relativity, if not the negation of an ether, at least something that rendered it no longer necessary. In view of this, it is to be welcomed that Prof. Einstein's inaugural lecture on "Ether and the Theory of Relativity," which was delivered in 1920 at the University of Leyden, has been made accessible to the English scientific public.

"The endeavour toward a unified view of the nature of forces leads to the hypothesis of an ether," and in the first lecture in this book is to be found an excellent account of the various phases through which the ether-conception passed in the forward trend of physical research. The ether gradually became divested of its mechanical properties until, with the advent of the special theory of relativity, it was deprived of the "last mechanical characteristic which Lorentz had still left it"—its "immobility." But "to deny the ether is ultimately to assume that empty space has no physical qualities whatever," a view with which the fundamental facts of mechanics do not harmonise.

"According to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an ether. According to the general theory of relativity space without ether is unthinkable; for in such space there would not only be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any space-time intervals in the physical sense. But this ether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it."

The second lecture, on "Geometry and Experience," is an expanded form of an address delivered in 1921 to the Prussian Academy of Science in Berlin. In geometry, "axioms are free creations of the human mind. All other propositions of geometry are logical inferences from the axioms," and "the matter of which geometry treats is first defined by the axioms," or what Schlick aptly calls "implicit definitions." But geometry first becomes a natural science "by the co-ordination of real objects of experience with the empty conceptual framework of axiomatic geometry." "Geometry predicates nothing about the relations of real things, but only geometry together with the purport of physical laws can do so." The question as to the nature of the structure of a continuum is a physical one to which experience must supply the answer, and we must acknowledge Riemann's geometry to be correct "if the laws of disposition of practically rigid bodies are transformable into those of the bodies of Euclidean geometry with an exactitude which increases in proportion as the dimensions of the part of space-time under consideration are diminished."

The question of the spatial finiteness or otherwise of the universe appears to be definitely a "pregnant question in the sense of practical geometry." Einstein discusses this problem in its various aspects from the view-point of the results of the general theory of relativity, and shows how, by the use of an analogy in two dimensions, we may form a mental picture of a three-dimensional universe which is finite, yet unbounded, and not Euclidean, but spherical. He aims at showing "that the human faculty of visualisation is by no means bound to capitulate to non-Euclidean geometry."

To all lovers of logical and exact thought who are interested in the developments that have arisen in the wake of the theory of relativity, this book can be warmly recommended. The work of translation has been admirably done, and much of the *finesse* of expression characteristic of Einstein's writings has been retained.

Geographical Influences.

The Great Capitals: an Historical Geography. By Dr. Vaughan Cornish. Pp. xii+296. (London: Methuen and Co., Ltd., 1923.) 12s. 6d. net.

IT may be said at once that we regard this as one of the most important and original works in geography that have appeared within a generation. The volume should be looked upon by teachers of geography as essential to their studies. It cannot be denied that the book is not easy reading; it must have cost an immense amount of pains to write. The result is, however, worth the pains, and though readers who will follow every page with the aid of a good atlas may indeed find that they make but slow progress, they will be well rewarded for their labour and lose all desire to hurry through the interest roused by tracing the author's line of thought. There are no doubt many who, with the best will in the world, cannot find the necessary time to complete the study of the whole work. We would advise these first, if they must read the volume piecemeal, to keep it always at hand, and, second, at least to find the time to master the author's account, say, of the situation of Moscow (pp. 181-91) or London (pp. 211 and onwards). If one of these has been read with the necessary care, the reader, if he has been hitherto unfamiliar with the geographical point of view, can scarcely fail thenceforth to understand what geography means, and even professed geographers will be warned against one danger now rather prevalent arising from a too narrow study of "natural regions." Dr. Cornish never fails to take into account the wide-reaching influences on the rise and growth of towns.

The author's views on the special subject of his volume are set forth in his preface as follows:

"An historical examination of imperial capitals shows that their district is usually either a Storehouse, or a far-reaching Crossways near a Storehouse, seldom a Stronghold. Their political geography has one outstanding character, a forward, as distinguished from a central, site. The Great Power both of ancient and modern times has always been an incorporation of several States, and the characteristic site of the imperial capital is in or adjacent to that Storehouse of the dominant community of the empire which is nearest to the principal foreign neighbour."

This position the author endeavours to make good by ranging over all recorded time and the greater part of the world, examining his thesis in the light of the earlier and later history and geography of China, Japan, India, Persia, Mesopotamia, Italy and the Roman Empire of the West and East, Trans-Alpine Europe, North and South America, taking every opportunity presenting itself in the course of his investigation to show the infinite variety of ways in which geographical factors affect history and the course of events brings about changes in geographical values. On the whole, he may be said to have made out his case, and at any rate he has always something ingenious and interesting to say in support of it, not least when he is applying his theory to certain minor illustrations, as in dealing with the capitals of the "heptarchy" or the Iroquois capitals in the neighbourhood of the great lakes of North America. But he is not dogmatic. He will sometimes qualify his averments by an "I think" or "I suppose," and the very fulness with which he brings forward his arguments is an invitation to the student to judge before accepting, in Bacon's language "to weigh and consider."

If here and there are found some rather broad and questionable historical statements, the student should note that the validity of the geographical exposition is not necessarily affected thereby. The present reviewer lays no claim to any intimate knowledge of Indian history, but was rather startled on meeting with the statement (p. 28) that "twice in the course of history has a government seated and independent of foreign control, ruled the whole, or nearly the whole, peninsula," and he cannot find that it is fairly justified; but that does not affect the value of the author's geographical considerations as to Patna, the capital of "the Aryan Empire," or Delhi, that of "the Empire of the Mohammedan Moghuls."

The volume is illustrated by two maps, one showing "The Isothermal Frontier of Ancient Cities," the other "The Marmora Metropolitan Region." A few more maps of the latter kind would have assisted the student greatly. GEO. G. CHISHOLM.

Our Bookshelf.

Atoms. By T. C. Wignall and G. D. Knox. Pp. 288. (London: Mills and Boon, Ltd., 1923.) 7s. 6d. net.
White Lightning. By Edwin Herbert Lewis. Pp. iv+354. (Chicago: Covici-McGee, 1923.) n.p.

THESE two scientific novels both centre around the idea of liberating the energy of the atom—a theme first explored by Mr. H. G. Wells in "The World Set Free." They may be taken as indicative of the interest being taken by the public in the recent developments of physical science.

The first, "Atoms," a highly imaginative romance, reflects strongly some of the most cherished popular conceptions or misconceptions about the growth of science. Super-financiers contend with one another and with or through the regular international anarchist associations in an atmosphere of dynamite plots, assassinations, and impersonations, in order to corner the world's supplies of energy. A colossal plant for producing power from coal and distributing it by wireless springs up at the word of command, and is converted during erection into an atomic energy plant by the discovery of *sublimium*. Sublimium dis-

integrates everything it comes into contact with except *refracton*, and it is conveyed in capillary tubes of the latter, a metre thick in the wall, in minute quantities from the laboratory to the furnaces. The authors are clever enough to get the best out of both possible worlds, and succeed, not only in showing us the effects of Paris being converted into an inferno through anarchists blowing up the refracton tubes, but also at the same time to bring the venture to a brilliantly successful conclusion with the hero and heroine happily off for the honeymoon.

"White Lightning" is a most curious production. Each of its ninety-two chapters is named after one of the elements in the order of the Periodic Table, and, in most of the chapters, the author succeeds in bringing in some interesting allusion to modern discoveries in chemistry and physics, if not always specially connected with the titular deity of the chapter. The style is irritatingly disconnected and inconsequent, but it manages to convey some idea of the fascination and glamour of discovery and the enthusiasms of which it is born. Emanating from America, it is no surprise to find that this author's *dénouement* is to endow, through the generosity of his public-spirited characters, the hero and the heroine with a research laboratory to be devoted to the study of the liberation of atomic energy.

F. S.

The Great Flint Implements of Cromer, Norfolk. By J. Reid Moir. (Printed and published on behalf of the author for private circulation.) Pp. 39. (Ipswich: W. E. Harrison, 1923.)

The title of this book is scarcely adequate, for the work treats of many periods, from that of the "eoliths" to neolithic times. Many of Mr. Moir's views were at first regarded with profound scepticism, but are being accepted by an ever-increasing number of competent judges at home and abroad. In the work before us they are briefly summarised, but the account is too condensed to do justice to the author's discoveries. We hope that in the not distant future he will write a detailed work on the pre-history of East Anglia, and that it will be illustrated by Mr. E. T. Lingwood, the excellence of whose illustrations in the work before us is noteworthy.

Three important questions arise with regard to the Cromer flints here described: (1) Are they derived from Pliocene beds? (2) Are they artefacts? (3) If they are, to which cultural period do they belong? The evidence bearing upon the first two questions is only summarised in the work before us, though more fully stated in papers to which reference is made. After reading that evidence, and after a visit to the spot under the author's guidance, the reviewer is of opinion that Mr. Moir is correct in his contention that the flints were once embedded in a Pliocene pebble-deposit, and that many of them are undoubted artefacts. Stress is laid upon the last point, as the specimens figured here will probably be regarded with suspicion by sceptics, and many others which are not figured are more convincing.

The reference to the early Chellean period is regarded only as a probability by the author, but perusal of this and other of his writings leads one to consider that he has made out a good case in favour of this probability.

The Happy Traveller: a Book for Poor Men. By the Rev. Frank Tatchell. Pp. xii+271. (London: Methuen and Co., Ltd., 1923.) 7*s.* 6*d.* net.

The author of this distinctly original book is a Sussex vicar, and we can picture him setting out for Hierusalem from the Middeherst of the twelfth century, in robust amity with all whom he might meet upon the way. Once outside the door of home (p. vii), he is never conscious of an obstacle. Like the young Jesuit Thomas Stevens, whose letter is preserved by Hakluyt, he is going to see his first shark, his first flying-fish (p. 140), and to learn, by personal encounter, the essential glory of the earth. Even between the poplars of a *route nationale* Mr. Tatchell goes on foot. He is forced to embark on liners for the greater seas; but he has travelled as a steerage passenger and as a steward, and we learn that "the 'deck' passages on Japanese boats are especially good."

The lists of common phrases in foreign languages might well have been omitted. We cannot judge the Burmese and the six words of Papuan, and they may be "happier" than the French. Yet we should be sorry to lose the conversation between the vicar-designate and the Fijian damsel on pp. 225-6. The notes on local customs are always helpful, and are backed by a truly catholic philosophy. Touches like the following add a sparkle to the printed page. "If you want to preserve your illusions, do not visit Palestine" (p. iv). "Should you be attacked by a mob in the East, hurt one of the crowd and hurt him quickly" (p. 23). "If you are in the steerage, take also some fruit and jam and a bottle of rum, which nowhere tastes so well as at sea" (p. 139). R. L. Stevenson would have enjoyed this passage, and he would have endorsed the maxim on p. 7: "The beaten track is the best track, but devote most of your time to the by-ways."

G. A. J. C.

The Coconut Palm: the Science and Practice of Coconut Cultivation. By H. C. Sampson. Pp. xv+262+40 plates. (London: J. Bale, Sons, and Danielsson, Ltd., 1923.) 31*s.* 6*d.* net.

This book is a welcome departure from the usual type of manual that deals in generalities about the plant concerned, with a fuller account of the methods of cultivation. Its author is to be congratulated upon having broken new ground, and it is by such study as is described in this volume that we may hope to arrive in time at a really scientific method of cultivating and treating the palm. Detailed scientific observations are given, for example, upon the numbers, the direction of growth, and the behaviour of the roots, a subject upon which we have usually had only vague generalities to go upon. Many other subjects are treated in the same way, *e.g.* the flowering, the relative proportions of flowers that set fruit, and so on.

The second part of the book deals with plantation management, and gives a very good, clear, and well-reasoned account of the methods in use, and the reasons for them—an account which will repay study even by the experienced coconut planter. In Part III. the products of the coconut palm are dealt with, and the methods of preparation employed in South India, the coconut products of which command the highest

prices, are considered and discussed, and the reasons for the treatment are pointed out.

The book is the best that we have seen treating of the coconut palm, and should be in the hands of every one interested in the industry.

Department of Applied Statistics (Computing Section), University of London, University College. Tracts for Computers. (1) No. 4: *Tables of the Logarithms of the Complete Γ-Function to Twelve Figures.* Originally computed by A. M. Legendre. Pp. iv + 10. 1921. (2) No. 8: *Table of the Logarithms of the Complete Γ-Function (for Arguments 2 to 1200, i.e. beyond Legendre's Range.)* By Egon S. Pearson. Pp. x + 16. 1922. (3) No. 9: *Log Γ(x) from x = 1 to 50·9 by intervals of ·01.* By Dr. John Brownlee. Pp. 23. 1923. (London: Cambridge University Press, 1923.) 3*s*. 9*d*. net each.

(1) THIS tract gives a reprint of Legendre's table originally published in the (now rare) second volume of his "Traité des fonctions elliptiques" (1825). It records the numerical value of $\log_{10} \Gamma(p)$ from 1·000 to 2·000, at intervals of 0·001, to twelve places of decimals, together with the first, second, and third differences for interpolation.

(2) In the second tract before us we have $\log_{10} \Gamma(p)$, correct to ten decimal places, for values of p at intervals of 0·1 from 2·0 to 5·0, of 0·2 from 5·0 to 70·0, and of a unit from 70 to 1200. Second and fourth differences are tabulated also, giving all necessary assistance in evaluating the function for intermediate values of p. From the last entry it can be inferred that Γ(1200), or 1199 !, is an integer of 3173 digits.

(3) Finally we have $\log_{10} \Gamma(p)$ tabulated to seven decimals at intervals of 0·01 from 1·0 to 50·9. This pamphlet rounds off the work on the Γ-function in the present series of tracts.

The Diseases of the Tea Bush. By T. Petch. Pp. xii + 220. (London: Macmillan and Co., Ltd., 1923.) 20*s*. net.

THIRTY years ago planters were inclined, when an outbreak of disease occurred among their crops, to conceal it from general knowledge or observation as much as possible, the result being that little or nothing was known, from a scientific point of view, of the diseases attacking tea. As time has gone on, however, this has altered. Watt and Mann, in 1903, described about a dozen diseases, and in the present volume the number has increased to about sixty. Whether more harm is now being done by disease, however, is very doubtful; on the whole it is perhaps less.

The book is prefaced by one of the simplest and best introductions to the study of fungi that we have yet seen. The diseases are treated in order, according to whether they attack leaves only, leaf and stem, stem, or root; and for each disease the characteristic manifestations are described, with excellent figures of the most important, while at the end of the book instructions are given for the preparation of Bordeaux and other fungicidal mixtures for spraying—a treatment which has come into considerable use during recent years, and leaves but an infinitesimal trace of copper in the tea.

Bau und Entstehung der Alpen. Von Prof. Dr. L. Kober. Pp. iv + 283 + 8 Tafeln. (Berlin: Gebrüder Borntraeger, 1923.) 12*s*.

Two years ago attention was directed to Prof. L. Kober's view that folded mountain-chains are marginal features of a geosynclinal "orogen" nipped between two mutually approaching masses of "kratogen" in the depths (NATURE, vol. 108, October 20, 1921, p. 236). The present work embodies a lucid review of the researches of the last forty years in the Alpine region, which is intimately known to the author from the Pennines to the Transylvanian wall. Through all details, however, he maintains his outlook on the world at large. In neat diagrams he shows how a dual structure is traceable in the western United States, in the Caledonian orogen of Scotland and Scandinavia, and in the axis of Japan. The floor of the Tethys channel (Fig. 2) has been squeezed up here and there to form mountain bulges from Andalusia to Sumatra, over a distance of 14,000 km. In the Alpine region only, a one-sided character has been imparted to the mountain-mass, and this is due to the fact that the southern marginal range, the Dunaric, has been moved northward until part of it overlies the east Alpine sheet. In agreement with H. Roothaan (1918), Prof. Kober (p. 252) places the beginning of Alpine overfolding in Cretaceous times, and the main movements in the Oligocene period. To quote the final words of this stimulating volume, "noch manche Rätsel bergen die Alpen."

G. A. J. C.

Colour Index. Edited by Dr. F. M. Rowe. Part 1. Pp. viii + 48. (Bradford: Society of Dyers and Colourists, n.d.) n.p.

THIS is the first part of a work that is being published, in fourteen monthly parts, by the Society of Dyers and Colourists, Bradford, with the object of making available, in the English language, to dye users and all interested in colouring matters, the latest information concerning commercial dyes, their constitution, modes of preparation, and uses.

Part 1 deals with the nitroso, the nitro, and a portion of the azo colours, while it is understood that when the work is completed it will contain descriptions of some 1300 distinct synthetic colouring matters.

The information is set out in tabular form, closely resembling that used in the well-known "Farbstofftabellen" of Schultz, but with the welcome addition of ample space for notes, and brought up-to-date by the inclusion of much information that is lacking in the "Farbstofftabellen."

It is well produced, and is a work that should be in the hands of all who are interested in colouring matters, whether from a scientific or practical point of view.

The Birth of Psyche. By L. Charles-Baudouin. Translated by F. Rothwell. Pp. xxiii + 211. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1923.) 5*s*. net.

A SELECTION of short memories of childhood written as prose poems with a distinct consciousness of scientific value in their significance. The author has written a preface to the English translation, in which he defends the presentation of scientific material in poetical form.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Photochemical Production of Formaldehyde.

IN a recent paper (J. Amer. Chem. Soc., 45, 1184 (1923)) Spoehr states that he has been entirely unable to reproduce our results on the photochemical production of formaldehyde from carbon dioxide and water (Trans. Chem. Soc., 119, 1025 (1921)), and he invites us to describe our experimental methods in greater detail than we did in our original communication. Before replying to this invitation we have repeated all our experiments and the new results entirely confirm the old, and there seems, therefore, to be little or no doubt that by the action of short wave ultra-violet light on aqueous solutions of carbonic acid formaldehyde is formed.

The quartz mercury lamps employed in all our investigations are the U form made by the Hewittic Company and the current taken by each lamp is 3·5 amps. at 230 volts. About 75 c.c. of pure conductivity water were placed in a transparent quartz test tube 9 × 1 in., and a slow stream of carbon dioxide, prepared from pure marble and synthetic hydrochloric acid and washed with a solution of potassium bicarbonate, was passed through the water. The carbonic acid solution was kept cool by a narrow tube through which a stream of cold water was passed. Stringent precautions were taken to guard against contamination by organic matter, and the times of exposure varied from 18 to 72 hours. Since the most satisfactory test for formaldehyde appears to be Schryver's test we have used it in every case, and throughout the whole series of observations we carried out control blank experiments. The results obtained may be summarised as follows :—

1. No formaldehyde can be detected in the solutions if the distance between the lamp and test tubes is less than six inches and no screen is interposed.
2. Formaldehyde can be detected in the solutions if the distance between the lamp and test tubes is six inches or more.
3. The quantity of formaldehyde formed is increased if a plate of calcite is interposed, and in this case the distance between the lamp and test tubes can be reduced with advantage.
4. The quantity of formaldehyde found is increased if the solution contains calcium or potassium bicarbonate.

The amount of formaldehyde found, though absolutely definite, is very small (1 to 2 parts in 100,000), the reason for this being twofold. The absorption band of carbonic acid lies near to $\lambda = 220\mu\mu$ and the intensity of the radiation of the mercury lamp at or about this wave-length is exceedingly small, so that the velocity of formation of formaldehyde must necessarily be very slow, even assuming that the whole of the radiation is absorbed. A second factor is that formaldehyde in dilute aqueous solution is decomposed by very short wave-length light. Indeed, a 0·01 per cent. solution of formaldehyde through which carbon dioxide is passed is entirely decomposed in 24 hours if placed at a distance of 4 inches from the quartz mercury lamp. It follows, therefore, that the formaldehyde found in the solutions described above is only the excess of that formed over that decomposed. The very short wave-length radiations are more absorbed by air than is light of wave-length $220\mu\mu$, and thus an explanation is found of the fact that a minimum distance between reaction vessel and quartz lamp is necessary for positive evidence to be obtained of the production of formaldehyde. Since calcite absorbs all rays of shorter wave-length than $215\mu\mu$, the amount of formaldehyde is increased if a calcite screen is interposed and the minimum distance between lamp and test tube becomes no longer necessary.

In view of our two series of positive results it is surprising that Spoehr finds himself unable to confirm this reaction, since the evidence we have obtained seems to us to be conclusive. In his paper Spoehr states that he used the straight form of mercury lamp, and in this may be found a possible explanation of the failure which he has recorded. It is a known fact that the quartz mercury lamp deteriorates after use and loses its power of radiating short wave ultra-violet light. Prof. Allmand has proved this deterioration of a mercury lamp of the straight form and has been kind enough to communicate his results to us. It may be suggested that this fact explains Spoehr's failure to observe any formaldehyde, the necessary ultra-violet radiation from his lamps being too small in amount. We have noted that the U-shaped lamp does not deteriorate, or, if so, very slowly, since our lamps after many months' continuous use still ozonise the oxygen of the surrounding air, a photochemical reaction which is known to be stimulated by very short wave-length light ($\lambda = 200\mu\mu$).

The great dilution of the formaldehyde necessitates the use of a colorimetric test for its detection. In view of Willstätter's statement that the Schryver test is given only by formaldehyde and hexylenic aldehyde, this reaction has commonly been accepted as positive evidence for formaldehyde. We have, therefore, employed this test, having at the same time proved for our own satisfaction that it certainly is capable of detecting formaldehyde at concentrations of 1 in 1,000,000.

E. C. C. BALY.
I. M. HEILBRON.
W. F. BARKER.

Correlation of Upper Air Variables.

IN view of the importance of the subject, a few remarks with regard to the note in NATURE of May 19, p. 684, on "Correlation of Upper Air Variables" may perhaps be permitted me, chiefly with the object of making clear the real issues in this question. Dines [1] found very high coefficients of correlation (of the order of 0·8) between various upper air variables, specially with pressure at 9-kilometre level. This led to the formulation of the Dines-Shaw theory of the sub-stratosphere and the regions above 9 kilometres as the real seat of origin of meteorological causes. In 1920, Chapman [2] applied certain statistical corrections to the coefficients of correlation found by Dines and raised these to +1·00 in several instances. A correlation of +1·00 establishes absolute causal nexus. A conclusion of this nature demands close scrutiny, specially as it is being widely quoted and applied in current writings.[3] In a recent memoir [4] noticed in NATURE [5] I have examined the statistical analysis in some detail.

As regards Chapman's work, my chief criticism is this: he has neglected entirely the effect of correlation between "errors" of measurement. Taking

[1] M.O. No. 210*b*, Geophys. Mem. 2, 1912; M.O. No. 220*c*, Geophys. Mem. 13, 1919, etc.
[2] Proc. Roy. Soc. 98 A (1920), pp. 235-248.
[3] M.O. No. 220*i*, Geophys. Mem. 19, p. 215; Sir Napier Shaw, "The Birth and Death of Cyclones."
[4] Mem. Ind. Met. Dept., vol. xxiv. Part ii., "On Errors of Observation and Upper Air Relationships."
[5] NATURE, May 19, 1923, p. 684.

these into consideration, my analysis shows that: (A) the statistical correction may easily become negative; that is, the true correlation may be considerably lower than the observed correlation. On the other hand, if "errors" are independent (or as my analysis shows, for particular values of correlation between errors), then (B) the correlation may be positive as found by Chapman, and the true correlation higher than the observed. The question is: under which category (A) or (B) above does the work of Dines fall?

In the case of a balloon meteograph, all measurements are made on one and the same trace,[6] and the heights are calculated with the help of Laplace's formula.[7] This formula involves both pressure and temperature, and a detailed examination shows that it serves to introduce, through "interpolation," correlation between errors of measurement in pressure and temperature. Besides this "interpolation" effect, correlation may also be introduced through what Karl Pearson[8] calls the "atmosphere" of measurement and through correlation of successive judgments.[9] It is, therefore, not improbable that Dines's work falls under (A) and gives values of correlation coefficients higher than their true values. My contention is this: (C) in the absence of definite proof that Dines's work falls under (B), Chapman's corrections cannot be accepted as real, and, to be on the safe side, Dines's coefficients must be looked upon as giving superior limits to the true correlation.

Douglas[10] found the values of correlation between pressure and temperature at 10,000 feet to be 0·65, which is considerably lower than Dines's figure 0·77 (and still more so than Chapman's corrected value). I quoted Douglas's result, as I thought his work to be free from the peculiar "interpolation" correlation introduced by the use of Laplace's formula. On this view, Douglas's work would probably come under (B) and would give values of correlation lower than true values. I now find stated in the note in NATURE that I have fallen into error in thinking "that Douglas's coefficients are based on true heights." (The fault, however, is scarcely mine, for Douglas himself definitely stated[11] that his observations "refer to actual heights above mean sea-level, and not to aneroid heights.") On the present view, Douglas's work also would probably come under (A) above, and even 0·65 would seem to be too high a value for the true correlation. This corroborates my contention (C) that Dines's coefficients are probably too high. It is, therefore, clear that the rectification of my error has further strengthened my conclusion. I may note in passing that the low values of the coefficients obtained by Douglas may be easily explained in accordance with my analysis if we assume that the magnitude of the correlations between errors of measurement are lower in his case.

In my other memoir[12] I pointed out certain statistical discrepancies in the coefficients published by Dines. It is stated in the note in NATURE that I seem "to have confused the T_m used by Dines, namely, the mean temperature between 1 and 9 kilometres, with the mean temperature between 0 and 9 kilometres," and that this supposed confusion on my part "fully explains the discrepancies" noted by me. I am unable to agree with this, as I do not think I have made any confusion between the two mean temperatures referred to above. On p. 1 and p. 3 of my memoir I have explained clearly that T_s represents the mean temperature between 0 and Z kilometres, and I have kept T_s and T_m distinct throughout. It is true I have substituted $dT_s = dT_m$, but this is quite different from putting $T_s = T_m$, since dT_s and dT_m are both statistical differences (which would ultimately be summed and averaged out) and not analytic differentials. This substitution is further discussed on p. 6 of my memoir. Now if this substitution is justified, then it follows from Laplace's equation that: (D) in the case of the figures published by Dines it is actually possible to obtain higher values of the correlation coefficients at levels considerably lower than 9 kilometres. In view of the assumption involved it is, however, necessary to test (D) by direct examination of the data concerned. But in the absence of such examination it is not sufficient to state that "discrepancies can be explained."

[6] M.O. No. 210*f*, Geophys. Mem. 6, 1914.
[7] M.O. No. 223, "Computer's Handbook," Section 2.
[8] Phil. Trans. 198 A, 1902, "Errors of Judgment," etc.
[9] Egon S. Pearson, *Biometrika*, xiv., 1922.
[10] Quar. Jour. Met. Soc., xlvii., January 1921, p. 28, etc.
[11] *Ibid.* p. 25.
[12] Mem. Ind. Met. Dept., vol. xxiv. Part I., "The Seat of Activity in the Upper Air."

To sum up, the main problem is to find (*a*) the true correlation, and (*b*) the region of the best correlation in the case of upper air variables. It would seem that in view of (A), (C), and (D) above, the work of Dines and Chapman (which is flatly contradicted by that of Douglas) cannot be accepted as final either as regards (*a*) or as regards (*b*). Further advance is not possible without a thorough statistical scrutiny of the original data.

May I, therefore, suggest that (i.) the original material of Dines and Douglas (as well as other fresh material, if available) be published with clear statements about methods of measurement employed and actual formulæ (rigid or otherwise) used for computation of heights, and that (ii.) such material be submitted to some statistical expert like Prof. Karl Pearson for examination and report.

P. C. MAHALANOBIS.

Presidency College, Calcutta,
June 20.

THE results of the British Registering Balloon Ascents are published in full by the Meteorological Office in the Annual Supplement to the *Geophysical Journal*. A full description of the instruments, methods, and formulæ used have also been published by the M.O., and will be found in the "Computer's Handbook," M.O. 223, Section II., subsection ii. They are open to anybody for use, and if Prof. Mahalanobis will carry out the computation he desires he will earn the thanks of meteorologists.

It is difficult, however, to see how Prof. Mahalanobis can obtain a perfectly correct correlation coefficient, in view of the fact that, with a coefficient of 0·70 based on 400 observations, the causal standard error is as high as 0·025. This fact suffices to explain the differences between Dines's and Douglas's results, which can scarcely be called a "flat contradiction."

With reference to Prof. Mahalanobis' assumption, that $dT_s = dT_m$, it may be pointed out that the result of making this assumption is discussed in the papers to which he referred, and also that no claim to extreme accuracy in the correlation coefficient is made by Dines. (See M.O. 210*b*, bottom of p. 43, and p. 44, line 11; also *Beiträge zur Physik der freien Atmosphäre*, V. Band, Heft 4, pp. 222, 223, and 225.)

THE WRITER OF THE NOTE.

Tubular Cavities in Sarsens.

WITH regard to Mr. F. Chapman's letter on the probable æolian origin of sarsen rock (NATURE, August 18, p. 239), and his reference therein to my previous note, may I say that I was not referring to

the holes so frequently present in the blocks—which I was told, when a student at the Royal School of Mines, some forty years ago, might be due to the presence of roots and rootlets in the sand before consolidation—but to a special case in which all the details *suggested*, from my previous knowledge of such things, the work of marine or esturine annelids. Without having seen what I saw, Mr. Chapman questions the validity of the grounds for the suggestion.

There is no evidence that the blocks to which I referred originated in the Bagshot Sands. They may have been associated with the Reading beds.

Assuming that all the tubular cavities in sarsens were caused through the presence of roots and rootlets in the original sand, what evidence is there that such roots grew *in situ*? It may have been driftwood. Plenty of such wood is to be found, in a lignitic and pyritised condition, in some of the Bagshot beds. I have seen some sarsen rock passing into conglomerate, indicating the proximity of littoral conditions.

It would be of interest to know if Mr. Chapman has found any grains of comminuted land shells, burrows and bones of animals, and burrows and remains of insects in the consolidated dune-rock he describes.

C. CARUS-WILSON.

Strawberry Hill, Middlesex,
August 18.

Barometric Pressure in High Latitudes.

MR. R. M. DEELEY'S reply in NATURE of August 18 to my letter in the issue of June 21 does not meet my objection, and since he repeats the misleading statement that surface pressure is low at the poles it seems desirable to come to a closer definition of terms. In my letter I made it clear that surface pressure was to be regarded "high" at the poles, not so much in relation to the absolute value as with respect to the belt of minimum pressure—the theatre of maximum cyclonic activity—about latitude 60° N. or S.; but Mr. Deeley under the general term "Arctic regions" does not distinguish between the sub-polar regions about 60° N. or S. and the true polar regions about 90° N. or S.

In maps produced by the late Prof. H. Mohn in his masterly discussion of the scientific results of the *Fram* expedition of 1893–96, which confirm in a remarkable way previous work of the late Dr. A. Buchan (see, for example, "Encycl. Britannica," 1911 edn., Polar Regions), it is shown that in winter a ridge of high pressure (over 762 mm.) is located across the North Polar basin connecting the great Canadian and Siberian high pressure areas, and separating the deep barometric minima of Bering Sea and Iceland (748 mm.), and that this is the season when the pressure gradient is steepest on the north side of these minima, just as it is on the south side. Dr. G. C. Simpson's maps embodied in his famous Antarctic volume are no less emphatic about relatively high surface pressure around the South Pole, even on that part of the area which is high plateau, and the fact that the expression "Antarctic Anticyclone" is nowadays a household word among meteorologists, geographers, and geologists alike ought to prevent unqualified statements to the effect that the South Pole is a centre of low surface pressure. It has been found that towards both poles pressure decreases from lat. 40° N. or S. at the height of about 6000 feet, but at the surface the total effect of all layers is to produce that slight excess of pressure which permits the polar outflow of air which Mr. Deeley admits does take place.

Mr. Deeley then goes on to say that he has attempted to explain why these outflowing polar winds do not reach low latitudes. But any one who thinks in terms of daily weather changes instead of in the cast-iron terms of average wind and pressure charts must realise that polar currents *do* have abundant opportunity of reaching low latitudes at irregular intervals, this, furthermore, being a foremost point in the theory of Prof. Bjerknes. There is nothing which so paralyses meteorological thought as the habit of regarding mean charts as though they represented actual unchanging conditions rather than merely the generalised expression of conditions which are perpetually varying to such an extent that the average type depicted is comparatively seldom realised, is generally to a greater or lesser extent distorted, and occasionally altogether subverted or inverted, as during our spells of east wind in the belt of "westerlies."

Finally, whatever effect the stratosphere may have on pressure at sea-level, Mr. Deeley appears to forget that the broad facts of low winter pressure over the oceans and high continental pressure are mutually complementary, as also the reverse distribution of high summer oceanic pressure and low continental pressure, and are well known to be due to seasonal contrasts of surface temperature, the difference of both pressure and temperature being greater in winter.

L. C. W. BONACINA.

27 Tanza Road, Hampstead, N.W.3,
August 19.

Is there a Change of Wave-length on Reflection of X-rays from Crystals?

A. H. COMPTON (*Phys. Rev.*, 21, 207) has recently shown that there is a change of wave-length when X-rays are scattered by an amorphous substance. If reflection of X-rays from crystals is a special case of scattering it would seem that there might be also a change of wave-length on reflection. Assuming such a wave-length change, we have for reflection from a single plane of atoms

$$(1) \quad . \quad . \quad . \quad . \quad \frac{\cos\theta_1}{\lambda_1}=\frac{\cos\theta_2}{\lambda_2},$$

where λ_1 and λ_2 are the incident and reflected wave-lengths and θ_1 and θ_2 are the grazing angles of incidence and reflection respectively. For reflection from successive planes of atoms we have

$$(2) \quad . \quad . \quad . \quad \frac{d\sin\theta_1}{\lambda_1}+\frac{d\sin\theta_2}{\lambda_2}=n,$$

where d is the grating space of the crystal and n is the number of vibrations (an integer) difference between the waves reflected from two consecutive planes. Also we have Compton's change of wave-length formula

$$(3) \quad . \quad . \quad . \quad \lambda_2=\lambda_1+2\gamma\sin^2(\theta_1+\theta_2)/2,$$

where $\gamma=h/mc=0{\cdot}024$ Å.U.

From these three relations the formula for the incident wave-length λ_1 can be found in terms of d and θ_1, which is the angle measured experimentally. Let λ' be the apparent wave-length obtained from Bragg's law $n\lambda'=2d\sin\theta_1$. The relation between λ' and λ_1 is found to be

$$(4) \quad . \quad . \quad . \quad \lambda'=\lambda_1+\gamma-\frac{\gamma^2\sin^2\theta_1}{\lambda_1+\gamma}.$$

From this it appears that λ' is greater than λ_1, the true wave-length, by about 0·024 Å.U. Also it appears that λ' is less for higher orders of reflection, a result

which has been observed experimentally by Stenström and also by Duane and Patterson (*Phys. Rev.*, 16, 532). The latter find that the difference between the values of λ' when the tungsten line 1·473 Å.U. is reflected in the first and second orders from calcite is 0·00015 ± 0·00009 Å.U. Formula (4) gives a difference of 0·00007 Å.U., which is within experimental error of the observed difference. However, this difference may also be explained on the assumption of a refractive index for X-rays.

X-ray wave-lengths are also measured by observing the angle of deviation $(\theta_1+\theta_2)$ between the reflected and incident ray. This is particularly the case when the photographic method is used (Siegbahn, Dershem, Overn and others). Let λ'' be the apparent wave-length when $\theta_1+\theta_2$ is observed so that $n\lambda''=2d \sin(\theta_1+\theta_2)/2$. We now have a difference between λ' and λ'' on our theory given by

$$(5) \quad . \quad . \quad . \quad . \quad \lambda' - \lambda'' = \gamma \cos^2 \theta_1$$

to the first power of γ. For the lower orders of reflection this difference is approximately 0·024 Å.U., which should be easily observable. Overn (*Phys. Rev.*, 14, 137) has found λ'' for the above line. Comparing with Duane and Patterson's value of λ' for the same line we find the experimental value of $\lambda'-\lambda''$ to be 0·0005 Å.U., which is within experimental error of zero. This would seem to be decisive evidence that there is no change of wave-length when X-rays are reflected from a crystal.

G. E. M. JAUNCEY.
CARL H. ECKART.
Physics Laboratory, Washington University,
St. Louis, Mo., U.S.A., July 3.

On the Structure of the Molecule.

THE difficulty of reconciling the atomic systems of Bohr and of Langmuir, and of accounting for the attraction between atoms to form molecules and chemical compounds, might perhaps be elucidated in the following way.

If the analogy between atomic structure and astronomical planetary systems holds good, the atom is essentially a two-dimensional figure, while matter, which is composed of atoms, is essentially three-dimensional.

If then combination takes place between two or more atoms, it would be reasonable to suppose that

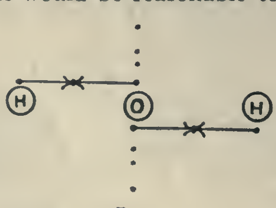


FIG. 1.

this does not take place in the same plane as the electronic orbit—an idea which is borne out by the work of Bragg on crystal structure.

We may suppose combination to take place somewhat as follows, in the formation of H_2O :—

If the plane of electrons be represented in Fig. 1 by the dots, it would be quite possible, if an electron were to be drawn out of the normal plane of each atom as indicated by the arrows, for it to form part of two atoms while revolving in a similar orbit to the original one but, owing to its divided allegiance, in a different plane. It would seem, however, that it would very soon take up a position directly between the two nuclei, when it would become *static*.

In the case of hydrogen, which has only a sufficient positive charge in the nucleus to hold one negative electron, if we suppose two electrons to be drawn out of the plane—one from each atom—the projection from the oxygen atom would be negative in sign, forming a negative link between two positive nuclei. This would perhaps explain the quite unique position of hydrogen in chemical combinations.

The system could be applied quite readily to more complex molecules. Bragg's model of the tartaric acid molecule (see NATURE of June 9, Supplement, p. ix) is readily amenable to this way of treatment,

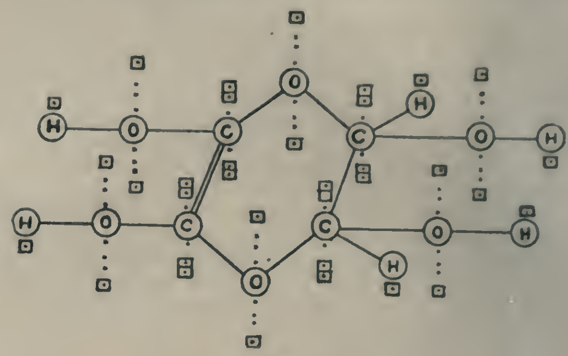


FIG. 2.

as the accompanying diagram (Fig. 2) will show, the electrons coming out of their respective systems being shown surrounded by a square.

It will be seen too from Sir W. Bragg's drawings that the links may easily be conceived as being in planes which would not interfere with the orbital motions of the remaining electrons.

The suggestion is then that, in the formation of the molecule, both dynamic and static electrons have their place, and this will throw considerable light on the nature of the links between the two or more positive nuclei.

A. PEARSE JENKIN.
Trewirgie, Redruth, July 20.

A Primitive Lens.

IF a wire of ½ to ¾ mm. diameter be bent into a closed circular loop of about 8 mm. diameter and dipped in water, or a transparent oil such as castor oil, a stable liquid film can be readily obtained covering the loop. A thin dished metal disc with a circular hole in the centre is a convenient alternative to the wire loop. Liquid can be easily added or removed without breaking the film, so as to vary the curvature of the liquid lens so formed. Such a lens, though far from perfect, may be made to give a magnifying power of nearly 5 over a small field.

It is conceivable that some of the very fine work done in Egypt, long before the invention of "optical" glass, may have been made possible by the use of a liquid lens of this kind. The phenomenon might easily have been accidentally observed; for even a drop of water lying on a greasy surface gives a small but appreciable magnification of the surface which it covers.

By using a thicker wire (about 2 mm. diameter) and less liquid, a diminishing lens may be made in the same way.

R. A. S. PAGET.
East India House, 74 Strand,
London, W.C.2,
August 14.

Baluchitherium osborni and its Relations.

By C. FORSTER-COOPER.

THE history of the discovery of the various fragments of Baluchitherium, which have enabled Prof. Osborn to make the preliminary restoration here reproduced (Fig. 5),[1] is interesting. In 1910 the present writer was fortunate enough to obtain bones of numerous extinct animals in the early Miocene deposits of Baluchistan. Nearly all of the animals were strange and, except for such of them as had previously been

FIG. 1.—Atlas of Baluchitherium with one of a modern rhinoceros.

obtained by Dr. Pilgrim of the Indian Geological Survey, were previously unknown. Among them an atlas, the first bone of the neck (Fig. 1) and an astragalus, one of the principal bones of the ankle, were of such astounding size as to proclaim themselves as belonging to an entirely new form of mammals, and one larger even than the elephant. Beyond the fact that the bones belonged to the Perissodactyla, a group which includes the horses, tapirs, and rhinoceroses, together with some extinct families, nothing further at the time could be said of them.

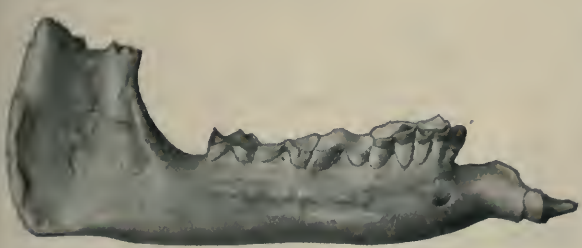


FIG. 2.—Lower jaws of Paraceratherium, showing the unusual feature, for a rhinoceros, of procumbent lower tusks. The length of the actual specimen is 30 inches.

During an expedition to the same place in the following year further remains were obtained, which comprised other vertebræ, limb and foot bones of this large animal, together with teeth of a large but primitive rhinoceros, some fairly complete skulls, and a lower jaw of a size to correspond with the skulls. The lower jaws, although obviously belonging to a rhinoceros of some sort, and one of considerable size, showed a unique feature in that the two front teeth were modified into a pair of stout, downwardly turned tusks (Fig. 2). Neither skulls nor jaws appeared to be of sufficient size to belong to the animal which possessed the atlas. In fact, the former animal appeared to be nearly twice the size, and on these grounds separate genera were made, Baluchitherium for the larger form and Paraceratherium for the smaller.

A few years later the Russian palæontologist Borissiak discovered the remains of a very similar large animal in Turkestan, which he named Indricotherium, but he likewise failed to get the skull. This regrettable lacuna in our knowledge has within the last few years been filled by the discovery of a nearly complete skull in Mongolia, a discovery which we owe to Granger, of the American Museum of Natural

FIG. 3.—Femur and humerus of Baluchitherium.

History's expedition to China. This skull is five feet in length, and thus all requirements as to size are abundantly filled, and with it enough bones from Baluchistan, Turkestan, and China (the wide separation of these areas shows the great range of distribution of the animal in former times) are known to enable us to make an approximate restoration, and to give us a reasonable idea of what the animal looked like while still alive.

Baluchitherium on reconstruction proves to be a very strange animal. The limbs are as large as those of an elephant, and in some points are not unlike them (Fig. 3). The feet, however, are entirely different in structure, the fingers and toes, of which there are only three to each foot, are much flattened, while the metacarpals and tarsals are enormously elongated (Fig. 4), so much so that the wrist is elevated nearly a yard above the ground, three times as high as the corresponding measurements in the elephant. Of the three toes, the central one is much the largest, the two lateral ones being pressed close to its sides, rather like the splint bones of the horse, though here the side toes are complete. There are some very curious, and as yet not fully understood resemblances to the horse in

[1] Prof. H. F. Osborn in *Natural History*, vol. xxiii. (New York), gives an excellent and fully illustrated account of Baluchitherium and its relations to other rhinoceroses. There is also a figure of the skull found in Mongolia.

certain of the foot bones, and notably in the neck. The neck bones, in fact, of all the many animals with which Baluchitherium has been compared, come

FIG. 4.—Toe bone of Baluchitherium, 15 inches long, with the corresponding bone of a modern rhinoceros for comparison. Larger bones than the one figured have been found.

nearest in proportions and shape, though of course not in size, to those of the horse. They show, however, one feature, which is unique in mammals and can only be paralleled in certain of the gigantic extinct reptiles, in that the lateral canals through which a blood-vessel runs are hollowed out into large cavities. These are so large that the central portion of the vertebra is reduced to a thin vertical partition, and in section [2] the bony parts of the centrum have a I shape; in fact Baluchitherium, in order to combine lightness with the necessary strength, has hit upon a design well known to engineers in the construction of girders.

Owing to the size of the limb bones and the height of the feet, Baluchitherium must have stood from twelve to thirteen feet from the ground, and with its horse-like neck and five-foot skull, an enormous skull length for a land mammal, must have had an over-all length of at least twenty-three feet! One curious point in all this bulk is that the head seems almost too small for the body!

The gigantic size of this animal can best be seen from the figures of Prof. Osborn [3] of his restoration of Baluchitherium (Fig. 5) compared with a white rhinoceros drawn to the same scale. It will be noticed that Baluchitherium, as restored, is considerably higher in the fore than in the hind quarters. This is a perfectly reasonable restoration on the assumption that the animal very probably fed upon the leaves of trees, but until the limb bones of a single animal are obtained it cannot be proved. An alternative restoration, also by Prof. Osborn, more on the lines of an ordinary rhinoceros, gives a somewhat different appearance.

The relationships of this animal are at present obscure.

It is certainly a rhinoceros, but unlike any known form, modern or ancient. In the teeth and skull, except for strong downwardly turned upper tusks, it is like the extinct hornless Aceratherine rhinoceroses, but the "horselike" features of the feet and neck preclude any close connexion. There is no suggestion of any but superficial resemblance to the horses, from which the tooth structure alone would at once exclude it. In fact it will be necessary to go back a long way in time to find the starting-point of Baluchitherium, and this point is at present unknown, although the present writer has suggested the little Eocene Triplopus, a rhinoceros-like animal with certain horse-like features in its limbs, as a possible signpost.

In his reconstruction Prof. Osborn has restored the fragment of lower jaw on the lines of the lower jaws of Paraceratherium (Fig. 2). The relations of these two forms are not yet clear. Baluchitherium is nearly twice the size of Paraceratherium, which is rather too large to be accounted for as a sexual difference. Moreover, there are a number of differences in

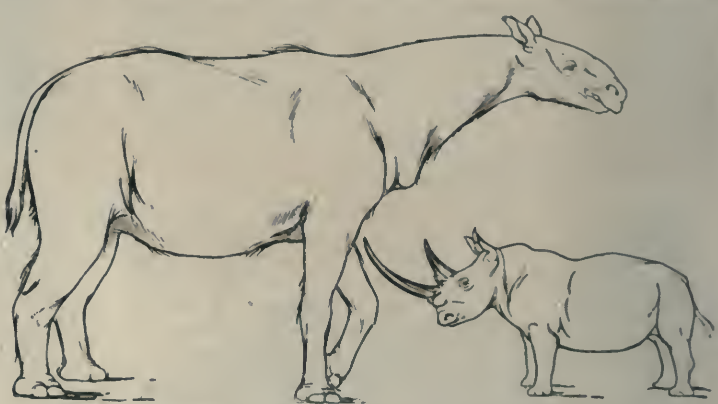


FIG. 5.—Restoration of Baluchitherium, with outline of the white rhinoceros for comparison. (After Osborn.)

the skull and teeth which render it probable that the forms are really different. It is much to be hoped that the American expedition will be successful in finding the front part of the lower jaw of Baluchitherium, which will go far to decide the point.

[2] A cast of one of these vertebræ in section, together with the original bones of Baluchitherium, can be seen in the palæontological gallery of the British Museum (Natural History).

[3] *Loc. cit.*

Nutrition Problems during Famine Conditions in Russia.

By Prof. BORIS SLOVTZOV, Professor of Biochemistry at the Medical Institute for Women at Petrograd.

I AM glad that it has fallen to my lot to be one of the first physiologists to get through the cordon which has almost come to be considered as a kind of a second Chinese Wall. Russian scientific men have been cut off from Europe for about eight years, and have therefore been obliged to follow their scientific work in their own way.

Now that we are gradually becoming aware, through the literature and by means of personal observation, of the intensive work that has been done in the West,

especially in England and America, we realise to our dismay how much we are behind in our results, and how bad are the conditions under which we are working and are likely to work for some time. We have, however, in accordance with our possibilities, achieved a certain amount of work which, I hope, may be of interest to our colleagues in physiology and physiological chemistry. I can only give the main results we have obtained, but it provides an insight into the trend of scientific thought which has prevailed in Russia during the period of isolation.

Soon after the post-War conditions had brought about a state of affairs in which it became difficult to feed the population and the available food became less and less, Russian scientific men were faced with the task of investigating various nutrition problems. A number of emergency substitutes such as bran, oil-cakes, straw, etc., were suggested to the public. It became necessary, therefore, to establish a standard according to which the nutritive value of the different substitutes could be assessed. As in Germany, it became at first necessary to prepare bread with various grasses and to mix large quantities of potatoes in the flour. The conditions under which a bread could be prepared that could be employed as a basal-food product had to be worked out. It became necessary to make use of the experience of other countries, especially Austria. At one time the advisability of feeding on whole-meal bread, as was done in Italy, was considered. This, however, was found unsuitable and uneconomical. Then we had to set to work in order to find out how a number of natural foods such as plants and roots, *Lichen islandicus*, *Laminaria digitata*, could be utilised. With this purpose in view, a series of metabolism experiments were carried out with bread to which these substitutes were added. The most successful results were obtained with Laminaria, of which 70 per cent. was utilised by the system; 25 per cent. of Iceland moss and quantities up to 50 per cent. of various green plants were also found to be assimilated. Of course plants are not utilised well, owing to the high content of cellulose, and several methods were considered in order to overcome this difficulty. One way considered was to pulverise the cellulose and free it from lignin; another, to bring the cellulose into a soluble state.

In this connexion a Swedish preparation known as "Swedish flour" was of interest to us. This product consists of pure cellulose and is ideal in its physical consistency. It is light, porous, and does not irritate the intestine in the slightest degree. Metabolism experiments have, however, revealed that the output was equal to the intake, and that there was no utilisation of the product. Occasionally the output was less than the intake, and in these cases the deficit could be accounted for quantitatively as methane in the expired air.

The attempt to utilise bran in its entirety was of greater interest. The bran was mixed and fermented with lactic organisms at 40-45° C. for 15 hours. The cell-membranes were thus disorganised and the cell contents were made available. This can also be attained by means of autolysis by increasing the acidity with lactic acid to a strength of 0·1-0·15 per cent. When autolysis is complete, flour can be added and the mixture made into dough and baked. Bread prepared in this way was found to be utilised 5-6 per cent. better than a control bread, especially as regards protein. It contained a large amount of protein matter and vitamins. The liquid obtained by autolysing in acid medium or by fermentation with lactic organisms can also be utilised mixed with agar and gelatin as a nutrient medium for organisms.

A special commission was engaged in investigating the nutritive yeasts. The physiological and medical part of this investigation was worked out under my own supervision. It was established that *nutritive* yeast, beer yeast, and dried yeast form ideal foods rich in protein. Up to 85-90 per cent. of the material is assimilated, and palatable dishes can be prepared from it. Yeast alone cannot sustain life, as it does not contain fats and vitamin-A. If, however, yeast is mixed with a good fat it is capable of maintaining the existence of rats and mice.

Yeast, like meat extracts, promotes the secretion of the gastric and pancreatic juices, and greatly stimulates the action of salivary amylase and of trypsin. An adult organism can tolerate as much as 100 gm. of yeast without harm. Only a slight increase in the output of uric acid was observed. I am not going to discuss now the pharmacological side of this food, but I may say here that it stimulates growth in children and in animals, and that it increases the formation of hæmoglobin in blood in general.

Our interest in yeasts for nutritive purposes made us also investigate the part played by "mineral" yeasts which the Germans cultivated on ammonium sulphate and glucose. These are usually a mixture of bread yeast and *Mycoderma cerevisiæ*. They were found to be of little use for nutrition purposes.

Much more interesting were the results we obtained with the so-called "Fetthefe." The Germans wanted to utilise this substance as a source of fat, but were not successful. We adopted a different procedure from theirs. Cultures of *Endomyces vernalis* under certain conditions can produce as much as 18 per cent. fat calculated on dry matter. The investigation of the fat has shown that it mostly consists of triglycerides and resembles olive oil in composition. It is well assimilated. To prepare the fat by cultivating the organism in bottles was of course too expensive, and we adopted the following method of cultivation. Potatoes and other vegetables poor in fats and protein were sterilised and inoculated with *Endomyces vernalis*. After 5-6 days' growth the medium was dried. The product thus obtained is rich not only in carbohydrates but also in nitrogenous substance and in fat, and can, like the flour, be employed as a new article of food. As such it can be assimilated by human beings. Experiments are now in progress for the purpose of applying this process to animal nutrition.

When the famine abated the dietetic investigations became less urgent. Russian physicians and physiologists, however, collected interesting material concerning starvation. It is difficult to imagine the degree of starvation. The table below gives the official standard ration of the population according to status and age for most categories of Russian populace. Human life could not continue under such conditions, and the mortality was great.

OFFICIAL RATION, JANUARY 1, 1920.[1]

	Number of Persons.	Mean Calories per Person.
Hospitals	36,044	1805
Children's Hospitals	..	1513
Houses of Detention ?	6,214	1414
Asylums and Settlements	29,887 + 754	1828
Workers' dinner	..	424
Ordinary dinner	612,030	265
Children's dinner	..	408
Typhus ration	8,670	1937
Invalids' ration	1,200	1645
Ration of Red Army behind the lines	13,710	1507
Scientific specialists	..	2761
Learned men's ration	1,800	3600
Iron and wood workers	..	4600

In Petrograd and Moscow the famines were investigated in fairly great detail, and scientific material was obtained for two great conferences on the famine, the deliberations of which have so far not been published. As a president of one of these conferences I can give the most important and interesting points which have been elucidated and which are of interest from the physiological point of view.

First, the approximate weight of the body was ascertained, according to the French formula that when the length of the body in centimetres is multiplied by 0·4 the weight of the body in kilograms is obtained. We have measured the height and weight of many persons who died of starvation without any other complications, and the weight according to the formula was found to be 30-35 per cent. less than the normal. Thus the figures obtained on starving animals have been confirmed on human beings.

Chemical analysis of the organs of people who died from starvation has shown a great deviation from the normal, especially in the content of neutral and phosphorus-containing fats. There was a small decrease in weight in all organs with the exception of the brain. This had already been ascertained through laboratory experiments. Chemical analysis of the white and grey matter has further revealed a great change in the tissue of the grey matter by a large diminution, not only in the phosphorus-containing fats, but also in the general quantity of the protein. In certain cases this diminution was as much as 25 per cent. The small fall in weight in the brain can, therefore, be explained by the fact that the white matter which forms the greater part of the brain is least altered, while the grey matter is changed greatly in quantity and especially in quality.

Secondly, an experiment was carried out on a large scale to ascertain the influence of the absence of fats from the diet; a mass experiment which lasted about two years. Trading in food products was forbidden and the transport was disorganised. Consequently, a rationing system was enforced on the population. At first the rationing was restricted to bread only. After the second revolution, however, the population was divided for rationing purposes into four categories. The first consisted of workers, the second of officials, the third of the ordinary citizens, and the fourth of the former rich. The following table gives the actual rations. Afterwards every ministry undertook the rationing of

THE DAILY RATION OF THE FOUR CATEGORIES OF THE PETROGRAD POPULATION.

	Protein.	Calories.
1st Category	74 gm.	475
2nd ,,	40 gm.	240
3rd ,,	33 gm.	135
4th ,,	13 gm.	53

their own officials, leaving the general public on the above diets. I had the opportunity of obtaining the information dealing with the amount of food served out to a certain number of people during the period of two years. From these data it was possible to calculate the fat, protein, and carbohydrates consumed per person per day and to plot mortality curves according to diet.

The first maximum of mortality coincided with the general low intake of calories. During this period many people died. Before death, which occurred generally from intercurrent infections, they mostly manifested œdema. A very high mortality from insignificant causes was also registered during this period. The second mortality maximum coincides with the fat minimum. There were days when the daily fat intake averaged about 5 gm.—to all intents and purposes a fat-free diet. During this period deaths of undefined character were registered. The organs of the victims showed scarcely any change.

In the course of the famines it was also possible on several occasions to confirm the influence of the vitamins on human beings. It is interesting to record an outbreak of scurvy among various groups of people whose diet was quantitatively quite satisfactory, but lacked variety and consisted mainly of ingredients such as boiled millet, maize, etc. Such an outbreak took place in the fleet. The pathological change in the large intestine which was brought about by the one-sided consumption of millet was even named "Millet disease." The mucous membrane is penetrated by the small grains, which cause intense inflammation. By changing the diet and using large grains only this scurvy-like condition is cured. This confirms the work of American workers, showing that the physical condition of the food may be responsible for a change in the mucous membrane of the intestine, which may favour infection. Scurvy is a dietetic disease due to a deficiency of vitamin-C. and a consequent bacterial infection. No specific organism causing scurvy could be found.

Further, investigations during the famine have shown that the relative proportion of protein, fat, and carbohydrate in the diet play an important part in the nutrition of the infant. A great deal of information was obtained from infant institutions where, owing to the lack of fats, grave illnesses were prevalent, which, however, disappeared when butter was introduced in the diet. It is of interest to record the great diminution in the fertility of women and the cessation of the menstrual periods. Similar conditions were observed among animals by the veterinary surgeons.

[1] Although these amounts represent what it was proposed by the Government to provide, no doubt the actual supply often fell short of the quantities set forth in the table.—Editor of NATURE.

Current Topics and Events.

It is announced in the *Times* of August 28 that Prof. A. G. Green, director of research of the British Dyestuff Corporation, has resigned his post on account of "dissatisfaction at the lack of technical knowledge on the board of directors, and his belief that the permanent establishment of the dyestuff industry in this country is impossible under these conditions." In Great Britain it is common for power to be in the hands of people without the scientific knowledge essential to make the best use of it for industrial and social progress; and Prof. Green has proved by experience what has often been pointed out in these columns and publicly stated by scientific workers in various industrial fields. In political appointments the same principle is adopted of placing the power over scientific departments in the hands of politicians without regard to their scientific knowledge or training. Sir William Joynson Hicks has, for example, just been appointed to succeed Mr. Neville Chamberlain as Minister of Health—this being the fourth Government post he has occupied in less than a year. Though it is accepted that a Chancellor of the Exchequer should know something about finance and a Solicitor-General something about law, apparently a Minister of Health need not know anything about science in order to control the manifold activities of a department mainly concerned with scientific problems.

A sensational report of a change of level of the bed of the Atlantic between Cape Town and St. Helena was made on the authority of the Eastern Telegraph Co. last week. It was stated that a cable repair-ship found a depth of three-quarters of a mile at a place where the chart showed a depth of three miles when the cable was laid in 1899. Changes of level of the ocean floor have often been brought to light by soundings, but the actual rise or fall is reckoned in a few feet or fathoms, and nothing of such a stupendous character as a change of more than two miles has ever been established by surveys. Decrease of depth could, of course, be caused by accumulation of the products of an eruption of a submarine volcano, and in such an event the rise of level would be local and the material would soon be worn down. Both Vesuvius and Etna began their careers as submarine volcanoes, and Sir Archibald Geikie records a number of submarine eruptions in his "Text-book of Geology," though nothing approaching the building of such a pile as would be required to produce the difference of level reported above. All that can be said at present, therefore, is that an actual uplift of the dimensions reported in so short a time is unthinkable and that the accumulation of volcanic material to produce the change of depth is extremely improbable. Confirmation of the accuracy of the old sounding as well as of the new will be required before any scientific significance can be attached to the report.

Several experiments have been made recently, both in America and in France, to instal a complete radio telephonic set in express trains. In the fast express train between Hoboken and Buffalo this has been done. Passengers can continue conversations with their friends which were interrupted by the train starting; they can also receive radio telegrams from their friends while the train is in motion. In *La Nature* for August 18, a technical description is given of the experiments which have been carried out by three of the French railway companies in making such "concert" cars. On the Paris-Orléans railway, the experimental saloon cars had two loud-speaking telephones fitted at each end of the cars. Up to a distance of 210 miles from Paris, the Eiffel Tower concerts were heard quite satisfactorily. As a rule the concerts were better heard than the news items. When the train goes through deep cuttings the sound is notably reduced, and when going through long tunnels it almost disappears. As there are at present only three large broadcasting stations in the neighbourhood of the railway, and as these are near Paris, the concert cars have only a limited use. With the arrangements used it was found that the large radio telegraphic stations near the Bordeaux-Paris line produced serious disturbances. When going round curves also, discordant sounds were heard due to the friction of the flanges of the wheels on the rails.

"Climbing Mount Everest," the cinematograph record of last year's attempt to scale the world's highest peak, was presented in a revised edition with several new photographs on August 27 at the Polytechnic Hall, London. Capt. J. B. L. Noel, who took the photographs, provided an interesting running commentary as the pictures appeared, while the orchestra played "Airs of Tibet and Nepal," collected in Tibet by Mr. J. Howard Somervell, one of the party of four who made the first attack on the summit. Frankly an entertainment of great and vital interest, designed to raise funds for an attempt on the peak in 1924, this pictorial account of the greatest achievement in mountaineering has been wisely chosen by Natural Films, Ltd., to inaugurate by a four weeks' season the series of travel and interest films which are to be presented to Londoners at this hall during next winter. While Capt. Noel deliberately emphasised merely the sporting nature of the climbing effort, his pictures show a much wider outlook; of particular scientific interest are pictures of the land forms and the force of the prevalent westerly winds, and also of the customs and ceremonials of the Tibetans.

The fourth annual report of the Tidal Institute of the University of Liverpool describes further developments in the work of this vigorous young institution, though much of the work referred to is not yet ready for publication. Only a few of the more interesting features can be mentioned here. A study of the effect on the sea-level at Liverpool, of winds operating in the Irish Sea and in the Atlantic Ocean respectively, shows that their importance is in the ratio of about 2 : 3. The purely local winds seem to be less important than was hitherto supposed.

The Institute has undertaken the analysis of records for the Australasian Antarctic Expedition, 1911–1914, the Cope Antarctic Expedition, and the Gold Coast Survey. It has also prepared for the Admiralty a chart of co-tidal and co-range lines in the North Sea constructed on a new plan, namely, by calculation from the tidal current data, using the dynamical equations which connect the currents with the surface gradients. Similar methods have been applied to the tides of the northern portion of the Irish Sea. Much work has also been done on the more purely mathematical branches of tidal theory.

THE work of the National Institute of Agricultural Botany at Cambridge, though only started in the new buildings in 1921, has made sufficient progress to justify the issue of an annual journal embodying the chief scientific results obtained year by year. In the first number the director reports on the potato maturity and yield trials, from which it is already possible to draw trustworthy conclusions in spite of disturbances to the results brought about by such factors as the use of seed tubers drawn from different districts, and in some cases affected with virus disease. The barley trials, however, do not as yet warrant the publication of a detailed account, owing to unfavourable weather conditions during 1922, but it is hoped that by the end of the next season it will be possible to make a critical analysis of the experimental results. The included fifth annual report of the Official Seed Testing Station indicates that much wider use is being made of the facilities provided, 25 per cent. more persons having submitted samples, the increase in the number received from farmers being 35 per cent. An interesting innovation was a course of training in seed testing, followed by practical and theoretical examinations, several of the candidates being nominated by various seed firms. The journal (which may be obtained from the Secretary of the Institute, Huntingdon Road, Cambridge, price 1*s.* 1*d.* post free) concludes with the report of the Potato Synonym Committee and a synopsis of recent work on leaf roll and mosaic of the potato in Ireland, read before a special meeting of fellows of the Institute.

AN interesting note by Dr. R. C. Benedict upon laws introduced by various States in U.S.A. to protect rare wild plants is published in *Science* for July 20. More than forty species of wild ferns and flowering plants are protected in Vermont by an act passed in 1921; Connecticut legislated to protect the climbing fern, *Lygodium palmatum*, so long ago as 1867, and has since introduced new statutes extending the list of protected plants; it has also enacted that shipments of wild plants, legally sold as from private land, must bear definite indications of their source, while written permission from the landowner must be filed with the county officers. California protects the Toyon berries (*Heteromalis arbutifolia*) so much in demand for Christmas decoration, while practically all the wild flowers of Yosemite are protected. Massachusetts has also passed a comprehensive law, and Dr. Benedict quotes with approval the text of a plant protection law recently proposed in Illinois. The many plant lovers interested in legislation to protect British wild plants would probably find the numerous legislative experiments in this direction made by the different States a valuable source of information on the subject, especially if trustworthy information can also be obtained as to the degree of success obtained. Dr. Benedict states that evidence from both botanical and commercial sources indicates that the Vermont legislation has proved effective. Some laws have probably been badly drafted; Dr. Benedict emphasises the fact that the plant must be treated differently from the migratory animal; it belongs to the land on which it grows and, except perhaps in the case of infectious disease or poisonous plant, the State may not restrict the farmer's operations upon the land.

AT the third annual meeting of the British Chemical Plant Manufacturers' Association, held in London on July 18, the chairman (Mr. L. M. G. Fraser), in moving the adoption of the annual report, directed attention to the principal aims and activities of the Association. He said that a great deal of work has been carried out by its committee in standardising various types of chemical plants, and that consequently manufacturers have altered their patterns at considerable trouble and expense, for the ultimate advantage of chemical manufacturers. Also, the properties of chromium steel have been thoroughly investigated, and it is hoped that a continuance of the work will lead to a satisfactory solution of some of the problems connected with the use and manipulation of the alloy in the construction of chemical plant. The technical chemist is constantly needing vessels capable of withstanding higher temperature and pressure than ever before, and the Association is fully alive to the importance of watching and following up the results of metallurgical research into suitable alloys for such purposes. In particular, need is felt for further technical research on the part of ironfounders into cast-iron, with the view of obtaining a closer grained and stronger metal more capable of resisting corrosion by electrolytic action. It is hoped that the Association will be represented on the Cast-Iron Research Association and other similar research organisations. An interim report has been presented to the Association of British Chemical Manufacturers upon the training of chemical engineers, which is full of difficulties in regard not only to the framing of a curriculum but also to persuading educational authorities to adapt their methods to new requirements. The tendency of present-day education is to be too intensive; a much broader training would be of far more use to the majority of men. It is to be regretted that, owing to insufficient support being forthcoming, the Association will not participate in the Chemical Section of the British Empire Exhibition next year.

WE regret to announce the death on August 26 of Mrs. Hertha Ayrton, well known in the scientific world for her researches on the physics of the electric arc and other subjects.

DR. GEORGE H. PETHYBRIDGE, until recently head of the Seeds and Plant Disease Division of the Department of Agriculture and Technical Instruction for Ireland, has been appointed mycologist to the Ministry of Agriculture and Fisheries for England.

DR. C. E. K. MEES has described, in the Journal of the Franklin Institute for August, the way in which the Eastman Kodak Company has sought to overcome the chief difficulties that prevent "motion photography" from being available for general purposes, reducing the cost and facilitating the development, etc., of the film. The "Cine Kodak" weighs about 8 pounds and takes 100 feet of film, which is equivalent, with its smaller pictures, to 250 feet of film of the standard size. The projector is driven by a motor so that it is automatic, and has a capacity for 400 feet of film, which requires 16 minutes to show on the screen. A large saving is effected in the cost of the film by its smaller size, and a further economy is gained in the majority of cases where only one film of the subject is required, by treating the exposed film by a reversing process, instead of making the positive by printing it on a second film. But "this is quite a complicated process and requires very special and complicated equipment" to avoid the appearance of graininess on the screen, so the Company undertakes this work itself. By these means the fifteen cents per second of picture as shown on the screen, which is about the cost of a standard film, is reduced to two and a half cents per second; and as 7 or 8 seconds is a sufficient duration of exposure for a single scene (such as a waterfall or a game), the cost for one subject is about 20 cents, and this compares favourably with the cost of making a negative and one print in the ordinary way. The film base is made from cellulose acetate, so that the risk from fire that the ordinary film of cellulose nitrate suffers from is practically done away with.

A NEW edition of his work on "The Endocrine Organs" is being prepared by Sir E. Sharpey Schafer for publication by Messrs. Longmans and Co. Part 1, dealing with the thyroid, parathyroids and suprarenals, will appear this autumn, and Part 2, embracing the rest of the subject and completing the work, next year.

Our Astronomical Column.

THE TOTAL SOLAR ECLIPSE OF SEPTEMBER 10.—This eclipse is total in south-west California and the adjacent islands; also in Mexico. There is no official expedition from the British Isles, but many of the great American Observatories are sending parties to observe it. *Popular Astronomy* for June-July contains an outline of their programmes. The Yerkes, Washburn, and Goodsell Observatories are occupying Catalina Island. The Washburn party will measure the brightness of the corona by the photo-electric cell; the Goodsell party will photograph the corona and star-field with an 8-inch lens, and the flash spectrum with a grating.

Mt. Wilson and Leander McCormick Observatories will occupy two stations; at Point Loma the corona and star-field will be photographed, also the spectra of corona and chromosphere; the interferometer will be used to determine the wave-length of the green coronal line and the rotation period of the corona. Their other station is at Lakeside, near the northern limit of totality, where the flash spectrum will be photographed with concave gratings.

The Lick Observatory, and the Students' Observatory of the University of California, will work together at Ensenada. The polarisation of the coronal light will be measured, and many other researches made.

The Sproul Observatory is occupying Cuencame, Mexico, and will photograph the corona both on a large and a small scale; also the flash spectrum. The interferometer will be used to study the rotation of the corona.

The University of Toronto will study the spectrum and polarisation of the corona.

The Steward Observatory (University of Arizona) and the Mexican National Observatory will also occupy stations in Mexico.

The Lick Observatory will not repeat the Einstein investigation, believing that the question was sufficiently settled at the eclipses of 1919 and 1922. The Goodsell, Mt. Wilson, and Sproul Observatories will take star photographs for this purpose, though the star-field is a poor one—less suitable than those of 1919, 1922. Signor Emanuelli, of the Vatican Observatory, gives a list and diagram of the stars in the region in *Astr. Nach.* There are three stars (magnitudes 8·8, 8·5, 8·0) with Einstein displacement exceeding 1″; they are likely to be hidden in the corona: six stars with displacements between 1·0″ and 0·6″ (magnitudes 8 to 9); thirteen stars between 0·6″ and 0·4″; fifty-eight stars between 0·4″ and 0·2″. Some of these last are fairly bright, one being σ Leonis.

INTERNAL MOTION IN THE SPIRAL NEBULA MESSIER 33.—Mr. A. van Maanen contributes another of his important papers on internal motion in the spiral nebulæ to the *Astrophys. Journ.* for June.[1] The measures were made on pairs of plates taken with the 60-inch reflector, the time interval being 12 years; 24 comparison stars and 400 points presumably belonging to the nebula were measured. One of the latter shows an annual displacement of 0·136″, so that its connexion with the nebula is disproved. The remaining points when plotted show consistent motions outwards along the arms of the spiral. The mean annual motion of the nebula as a whole, relatively to the comparison stars, is +0·003″ in R.A., −0·004″ in decl. The motions of the nebular points, in addition to their outward movements, indicate rotation in periods varying from 60,000 years for the inner portions to 240,000 years for the outer ones. The mean component of velocity along the nebular stream is +0·020″; it increases slightly as the distance from the centre increases.

Mr. van Maanen gives in full the reasoning which leads to the conclusion that these displacements are real. Taken in conjunction with the radial velocities measured, they indicate a parallax of the nebula of the order of 0·0005″, or a distance of 6000 light-years. The diameters of the spirals are many light-years (in some cases hundreds of light-years), but they are much smaller objects than the Galaxy.

Research Items.

SKELETON FROM AN ANCIENT WORKING IN RHODESIA.—In the Proceedings of the Rhodesia Scientific Association, vol. xxi., 1922–23, Mr. G. Arnold publishes a report by Sir Arthur Keith on a skeleton found in an ancient working near the Gwanda Mine. Sir Arthur Keith thinks that the skeleton may be ten centuries old. The remains are those of a young woman about 20 years old, and the character of the face and cranium show that she was a negro of the type so often seen among Matabele and Zulu women. It is to be remarked that the outer margins of the crowns of the more anterior teeth have been chipped during life, as if hard nuts or bones had been cracked in the mouth. One remarkable feature is the non-development of the upper wisdom teeth: they have never been formed, a common occurrence among European women, but uncommon among negroes.

A SAXON GOLD RING FROM YORKSHIRE.—Many years ago the late Canon Greenwell informed Mr. T. Sheppard, Curator of the Hull Museum, that a massive gold ring had been found in a Saxon burial ground near Driffield, East Yorkshire. Inquiries were made from a person who was believed to hold it, but in vain, until recently it appeared in the window of a Piccadilly jeweller, whence it was purchased for the Hull Museum. It weighs 15 grains and has a large oval bevel, in the centre of which is a fine garnet held by a plate of gold; the face of the ring is decorated with ornamentation made of fine gold wire. This seems to be the third record of a ring of this type, other specimens being deposited in the Ashmolean and British Museums—the two latter rings bearing the inscription "Nomen Ehlla Fides in Christo." Objects of a similar type are described by Mr. Sheppard in pamphlet No. 134 of the useful series issued by the Hull Museum.

THE EASTER ISLAND STATUES.—The interest of archæologists has been excited by the account by Mrs. Routledge of the remarkable statues of Easter Island. Mr. H. G. Beasley, in the August issue of *Man*, describes an image only 9¾ inches high, which he was lucky enough to pick up at a shop on the Continent. It seems to be of the technique of the Easter Island statues, the material being a piece of volcanic ash, once covered with red ochre, which appears to be the effigy of some worthy, in honour of whom it was smeared with red, like images in India, the red being the survival of a blood sacrifice. The domed head of the image is remarkable, as Mrs. Routledge found only one example of this type in the course of her excavations. Her inquiries show that, in addition to the great statues raised on platforms in Easter Island, a variety of smaller stone objects were made for personal use, and as niches are found in the inner walls of the houses, small images such as this may have been placed therein.

THE EVOLUTION OF THE PALÆOZOIC FLORA.—In recent years considerable attention has been given by botanists to the lines along which the Upper Devonian flora developed, and the characters of the Middle Devonian flora of the cherts of Rhynie in Aberdeenshire have given attraction and urgency to research into still older plant-remains. This point is emphasised by Dr. A. C. Seward as president of the Geological Society of London, in his address published in the Quarterly Journal of that Society for July, 1923 (vol. 79, Proc., p. lxvi). Unfortunately, he can hold out but little hope of terrestrial plant-remains of pre-Devonian age. Vegetation still clung to the swampy fringes of the continents and islands until the epoch of the Rhynie beds. It was not till Upper Devonian times (p. ciii) that it "had come into its own, and had colonized the higher and drier ground." The "change in the geological background had its reflex in the development of green foliage in place of the almost leafless condition of the older plants." The rest of this sentence ("destined to live in localities either physically or physiologically dry") seems to have got somehow out of place. In dealing with the Archæopteris flora, Dr. Seward asks how such plants were adapted to survive the long months of arctic darkness; but he feels that we are not yet "in a position to demand as a necessity either a shifting axis or a wandering crust." The critical horizon indicated by the Rhynie peat-bog has been discussed by F. O. Bower and D. H. Scott (NATURE, vol. 105, p. 681, 1920, and vol. 108, p. 153, 1921); and Dr. Scott has recently contributed a paper on the early history of the land floras (vol. 110, p. 606, 1922), which should be compared with Dr. Seward's address. Dr. Seward, however, carries the survey farther back, and reviews evidence that is rarely brought together as a whole. He remarks (p. lxxv) that Cryptozoon may be the skeleton of an animal, but is not a plant. Dr. O. Holtedahl has always viewed this genus and its allies with suspicion (*Amer. Journ. Sci.*, 4th ser., vol. 47, p. 85, and vol. 201, p. 195; see NATURE, vol. 103, p. 330, and 107, p. 795), and Dr. Seward has come independently to his conclusion that a comparison of its nodular masses with those formed of calcite in the Magnesian Limestone of Durham is fully justified. It seems that Cryptozoon, with its allies from Huronian to Carboniferous strata, is destined to go the way of Eozoon.

CRYSTAL CLEAVAGE AND CRYSTAL STRUCTURE.—Under the above title, Mr. Maurice L. Huggins has published in the *American Journal of Science* (vol. 206, p. 203, 1923) a number of diagrams and descriptions of crystal-structure, showing the probable position of electrons along lines representing bonds between the atoms, and he concludes that (i.) cleavage tends to occur so as to leave two new crystal surfaces that are electrically neutral; (ii.) if some bonds in the crystal are weaker than others, cleavage ruptures the weaker bonds in preference to the stronger ones; (iii.) if all the bonds are equally strong, cleavage will occur between the planes connected by the fewest bonds per unit area of the cleavage plane. Readers of NATURE have had their attention directed to the question of crystal strength and crystal weakness in Sir William Bragg's recent paper on crystal analysis (Supplement, June 9, 1923, p. v). Mr. Huggins conceives, however, that the splitting of a crystalline structure occurs between an atomic kernel and a group of electrons, or between two electron groups or two electrons in a pair, rather than merely between two atoms or planes of atoms. A simple illustration is seen in the two-dimensional diagram of bismuth structure in Fig. 7. The risk that we run—we who are not gifted with transcendental powers of introspection—seems to lie in regarding the circular atomic nuclei, and the smaller electron circles, in such diagrams as known physical entities, instead of as points at which something happens.

AN ANTARCTIC METEORITE.—The latest to be issued of the scientific reports of the Australasian Antarctic Expedition, 1911–14 (series A, vol. 4. pt. 1), is devoted to a description of the Adelie Land meteoric stone. The finding, on December 5, 1912, about twenty miles west of Cape Denison, of this small black object resting

on Antarctic snow was a remarkable chance. How many times since its fall from the skies it may have sunk beneath the surface by absorption of summer heat, to be exposed again by ablation, who can tell? The description by F. L. Stillwell, and very detailed chemical analysis by P. G. W. Bayly, show that the stone, which weighed originally $2\frac{1}{4}$ lb., is an "intermediate hypersthene-chondrite" containing about $6\frac{1}{2}$ per cent. of nickeliferous iron.

HOT WAVES IN THE UNITED STATES.—*The Scientific Monthly* for August contains an article by Prof. R. de C. Ward, of Harvard University, on "Hot waves, hot winds and *Chinook* winds in the United States." The subject is dealt with scientifically, and the meteorological aspect is rendered of considerable interest by the graphic descriptions introduced. Hot waves or spells of excessive hot weather occur at irregular intervals, and continue for varying periods of time; they are somewhat common to the summers of the central and eastern United States. A hot wave has not acquired the official definition similar to that attached to a cold wave. The heat is caused by the southerly and south-westerly winds that prevail in the front of a weak cyclonic depression as it moves slowly eastwards across the northern tier of states, and the air, coming from warmer latitudes, causes high temperatures, accompanied by high humidity and generally hazy skies. Under the high and powerful sun the thermometer may rise well into the 90's and even to 100° F. The night is likely to bring little relief except in the mountains and on the coast, and the minimum temperatures are often over 70° F. Occasionally two, or even more, hot waves come in succession with little interruption. A prolonged hot wave is commonly accompanied by drought. Hot waves are most pronounced in July, but they are often severe in August and September, and maturing crops are often injured. A detailed description is given of *Chinook* winds, which are distinctly of the *föhn* type, and are commonly experienced along the eastern base of the Rocky Mountains; in these a rise of temperature from below zero to 40° F. or 45° F. in a few hours is sometimes experienced.

EFFECT OF WIND DIRECTION AT JERUSALEM.—The Ministry of Public Works, Egypt, has recently issued a discussion, Physical Department paper No. 10, by Mr. S. Krichewsky, on "Effect of wind direction on temperature and humidity at Jerusalem." The author quotes Biblical passages showing the effect of the different winds of Palestine. He also refers to modern information by Dr. Chaplin, who made meteorological observations at Jerusalem from 1861 to 1883. Statistical research is now made by the author, using observations from 1896 to 1913 by the Deutsch Palästina Verein published in the "Wiener Met. Jahresberichte." Observations are used for 7, 13, and 21 hours daily. The north wind which has been described as cold only causes the mean temperature to be lower in the winter than when winds are blowing from other directions; in other seasons of the year the mean temperature of this wind is above the normal; as a rule north winds are rare. The south wind is more rare than the north wind, and it seldom blows in summer; it is chiefly in spring that a south wind is warm. The east wind is reputed to be hot and very dry, its humidity is always below normal, it is rare in summer but very frequent in winter. The east wind is the principal factor of drought and it generally raises the mean temperature above normal, especially in spring when the desert winds turn into *Sirocco*. The west wind is damp as naturally as the desert wind is dry; it is the most important wind of Palestine, and supplies water vapour which produces rain or dew; the west is the most frequent wind throughout the year. The west wind is the real factor of coolness in spring, summer, and autumn.

THE ACCURACY OF VISUAL OBSERVATION AND MEASUREMENT.—The effect of the physiological properties of the eye on the accuracy of measurement is considered in a comprehensive paper by Dr. H. Hartridge appearing in the *Philosophical Magazine* for July. On purely optical grounds it is deduced that for white light and a 3 mm. pupil the images of two objects formed on the retina must be separated by $2\cdot9\ \mu$ in order that they shall be resolved by the eye. The size of the foveal cones imposes a histological limit of $3\cdot2\ \mu$, in fair agreement with the first estimate. The limit to the resolving power obtained by actual experiments is not very different from this figure, results varying between $3\cdot6\ \mu$ and $4\cdot6\ \mu$ being obtained by using test objects of various types. An improvement of roughly 15 per cent. has been obtained by substituting pure green light for daylight. The visual acuity of the eye for the positions and movements of contours is nearly ten times greater than it is for the resolution of double points, and lines. For the movement of a contour to be perceived it must cause a cone on one side of the edge of the image to receive an appreciably stronger stimulus, and that on the other an appreciably weaker one, than before. The acuity of the eye will therefore depend less on the diameter of the cone than on its ability to perceive small changes in light intensity. Various types of linear measurements are considered in detail. The method of coincidences, as in the measurement of an object by a scale and vernier, is found by experiment to give very accurate results. The error in the setting of the image on the retina is less than $0\cdot76\ \mu$, corresponding to 10 seconds of arc. The interpolation method of measurement, as used in the slide-rule, is much less accurate. The errors to which these methods are liable are discussed by Dr. Hartridge, and the means of avoiding them is described. Attention is also directed to the contact method of measurement, and to measurements of depth and distance, colour and intensity.

FULLER'S EARTH.—A survey of the fuller's earth industry appears in the *Chemical Trade Journal* for July 27. The two main producers of this mineral are America and England, the whole production of the latter country coming from Somerset and Surrey. The article gives a critical survey of the properties, applications, and preparation of the mineral for the market.

THE EINSTEIN DISPLACEMENT OF SOLAR LINES.—According to Einstein's relativity theory, each line in the spectrum of an element on the sun should be displaced towards the red from its position for a terrestrial source by an amount equivalent to an increase of its wave-length of two parts in a million. In the June issue of the *Journal de Physique* M. F. Croze reviews the experimental evidence available and shows that though displacements of the order required are observed, they do not follow the prescribed law, but vary with the intensity of the line, and with the point on the sun from which the light originates. These deviations cannot be explained by the influence of pressure at the sun nor by the Döppler effect. The author is disposed to regard them as due to anomalous dispersion in the atmosphere of the sun, as suggested by Julius, and hopes to test this theory quantitatively by means of the observations now being made at Mount Wilson.

The Liverpool Meeting of the British Association.

Programmes of the Sections.

The provisional programmes of the various Sections of the British Association, for the meeting to be held at Liverpool on September 12-19, show that the meeting will be of decided scientific importance and interest. It will be noticed that a number of distinguished men of science from abroad are attending the meeting and taking part in discussions.

We are indebted to the Recorders of the Sections for the subjoined outline of arrangements made for sectional papers, joint discussions, lectures, excursions, and other means of recording progress and promoting critical consideration of methods, results, and principles.

Section A (Mathematics and Physics).

The proceedings in Section A this year give promise of being exceptionally interesting and valuable, mainly because an unusually large number of distinguished foreign visitors are expected to take part. Several countries will be thus represented; France, America, Denmark, and Holland. In addition to this, Canada will have representation in the sectional president, Prof. J. C. McLennan, whose address on "The Origin of Spectra" will form an opening for a series of papers on cognate subjects, "The Correspondence Principle," by Prof. N. Bohr, "Remarks on Quantisation," by Prof. P. Ehrenfest, and "The Structure of Atoms and their Magnetic Properties," by Prof. P. Langevin, whose promised visit will compensate for his inability to attend last year on account of illness. These papers will be taken on Monday, September 17.

On the first working day, Thursday, September 13, there will be a discussion, jointly with the Sections of Chemistry and Engineering, on "Cohesion and Molecular Forces," to be opened by Sir William Bragg. This will be followed by a paper by Prof. C. G. Darwin—who has just returned from Pasadena—in which he will describe the important recent work of Prof. A. H. Compton on the scattering of X-rays. The remaining principal item on the programme will be a sectional discussion on "The Spectra of the Lighter Elements" on Tuesday, September 18. This will be opened by the president, and contributions will be made by Prof. Bohr and Prof. A. Fowler, and, probably, Prof. R. A. Millikan.

Among the individual papers which will be read may be mentioned contributions by Sir O. Lodge on "Matter and Radiation," Prof. R. W. Wood on "The Effect of Weak Magnetic Fields on the Polarisation of Resonance Radiation," and Mr. G. Stead and Miss B. Trevelyan on "The Production of Triatomic Hydrogen."

There will be papers on meteorological subjects by Capt. D. Brunt and Mr. F. J. W. Whipple, and one by Dr. A. T. Doodson on tides in relation to meteorology. Papers relating to the mathematical representation of experimental results have been accepted from Mr. T. Smith, Prof. H. Levy, and Mr. H. W. Moore.

The afternoon of September 14 will be devoted to demonstrations, including Mr. W. M. Mordey's alternating magnetism experiments and Mr. S. G. Brown's "Frenophone" or friction-operated loudspeaker.

Section B (Chemistry).

The programme of Section B covers a wide range of subjects. The president, Prof. F. G. Donnan, will deal with the physical chemistry of interfaces, and the same subject will be followed into detail in a joint discussion between Sections B and I on membranes. A second joint discussion has been arranged with Sections A and G, the subject being cohesion and molecular forces. This will be opened by Sir William Bragg, Dr. Rosenhain, and Dr. A. A. Griffith, and an attempt will be made to bring together the physicists, the metallurgists, and the engineers in a consideration of the processes of rupture of metal test-pieces and similar matters.

There will be a group of papers on the theory of the atom, Prof. G. N. Lewis opening with an account of the chemical applications of the quantum theory, followed by Dr. Sidgwick on the Bohr atom and the Periodic Law, Dr. Coster treating the same subject from the spectroscopic side. Dr. Hevesy will give an account of his most recent work on the chemistry of hafnium. An echo of last year's discussion on photochemistry will be heard in the form of a note on the biochemical effects of polarised light from Prof. Baly's laboratory. Dr. E. F. Armstrong will open a discussion on enzymes, to be contributed to by Dr. K. G. Falk, and there will be notes on certain new points in the chemistry of cotton and of rubber. On the last morning of the meeting, Senator Ginori Conti will give an account, illustrated by slides, of the progress now being made in Northern Italy in the use of volcanic steam for technical purposes.

Other papers deal with the formation of precipitates, the functions of active hydrogen atoms in organic compounds, and the nature of the alumino-silicates. Liverpool being an important chemical centre, there will be a number of excursions of special interest to the Section.

Section C (Geology).

The Section will meet under the presidency of Dr. Gertrude L. Elles, whose address will be entitled, "Evolutional Palæontology in relation to the Palæozoic Rocks," and will, by her desire, be followed by a discussion. Local geology will figure largely in the programme: Prof. Boswell will give an address on the geology of the Liverpool district, and Sir Aubrey Strahan will open a discussion on the changes in the geography of the district during Pleistocene and recent times and their possible bearing on the development of Chester by the Romans and their total neglect of the now much superior waterway of the Mersey estuary. Other local papers are by Mr. C. B. Travis, on recent geological changes on the Northern Shore of the Mersey Estuary; Mr. T. A. Jones, on the Middle Bunter sandstones and their pebbles; and Miss M. Workman, on the Permian rocks of Skillaw Clough.

A discussion on metamorphism will be opened by Dr. J. S. Flett.

Other papers include Prof. Kendall on isostasy and the Pleistocene levels of Britain; Prof. Boswell on the geology of the East Denbigh Moors; Prof. Hickling on the tectonics of the Lancashire coalfield; Dr. R. L. Sherlock on British rock salt deposits; Mr. G. Slater on ice phenomena in Spitsbergen; Mr. K. W. Earle on the geology of the Windward and Leeward Islands; and Mr. C. P. Chatwin on a new gasteropod fauna from the Chalk.

Numerous excursions to places of geological interest will take place during the meeting, including an examination of the Upper Ordovician and Lower Silurian rocks of the Vyrnwy district and a whole day excursion to Holywell and other parts of Flintshire.

Section D (Zoology).

Prof. J. H. Ashworth, president of this Section, will take as the subject of his address "Modern Zoology: its Boundaries and Some of its Bearings on Human Welfare."

In drawing up the programme of the Section, Liverpool work in zoology, oceanography, and tropical medicine has been borne in mind. The whole of Friday, for example, will be devoted to marine zoology, comprising contributions from Dr. Johs. Schmidt, of Copenhagen, who will give a popular lecture on the scientific work of the Danish exploration steamer, the *Dana*, illustrated by cinematograph; from Dr. Mortensen and Mr. Kramp, both of Copenhagen; from Prof. Johnstone, on Rhythmic Change in the Plankton; from Prof. Dakin, who will discuss the theory of Pütter regarding animal nutrition; and from Mr. Storrow, Dr. Marie Lebour, Mr. Hardy, Mr. Carruthers, Mr. Clark and Mr. Chadwick.

On Tuesday morning there will be a series of papers bearing on the problem of the determination of sex, the contributors being Dr. Crew, Prof. Dakin and Mr. Burfield, Mr. Huxley and Prof. Carr-Saunders, Dr. Heslop Harrison, Mr. J. R. Baker, and Dr.Parkes. During one of the sessions, Prof. Hickson will open a discussion on the systematic position of the Nematoda, and Profs. MacBride and Goodrich, and Dr. Baylis, will take part in the discussion. Mr Huxley will give a semi-popular lecture on the physiology of development in the frog; Prof. Ashworth will make a contribution on the life-cycle of Rhinosporidium; Prof. Cole will explain some new points which he has brought to light in regard to the anatomy of Myxine.

Other contributors to the sectional proceedings will be Mr. J. T. Cunningham on the origin of adaptations; Prof. Poulton on a new case of mimicry; Dr. Heslop Harrison on polyhedral disease in the vapourer moths; Miss Dorothy Jackson on the Biology of a Braconid parasite of the pea-weevil; Mr. Peacock on parthenogenesis in saw-flies; Mr. Speyer on complex Aphid life-histories; Mr. Hewer on colour changes in the common frog; Dr. Baylis on the host-range of parasitic nematodes; Prof. Blacklock on two tropical disease-carrying flies; Prof. McIntosh on some points relating to polychaetes; Mr. Graham Cannon on the post-naupliar development of an Estherid crustacean; Dr. Grove on sexual congress in earthworms; Miss Breeze on invasion of the tissues of the higher plants by protozoan parasites.

A whole-day trip on the Lancashire and Western Sea Fisheries Committee's steamer, the *James Fletcher*, should be of interest to marine biologists, and a half-day in Delamere Forest should prove attractive to entomologists.

Section E (Geography).

The programme of Section E will open on September 13 with the address of the president, Dr. Vaughan Cornish, who will speak on the geographical position of the British Empire. The remainder of the morning will be occupied by papers explaining the local geography of the Liverpool district. Papers of this nature have been a feature of Section E for some years, and have been appreciated by visitors from a distance. In view of the location of this year's meeting, endeavours have been made to secure contributions dealing with Imperial geography, a question affecting the world-wide interests of Liverpool. Mr. O. H. T. Rishbeth will speak on Australian railway development, Miss B. S. Hosgood will discuss post-War emigration from the British Isles, and Mr. W. H. H. Arden-Wood will contribute a paper on the alluvial lands in India in relation to man and his activities. Other papers include the historical geography of Belgium, by Prof. L. W. Lyde, the Alps of Chinese Tibet, in which Prof. J. W. Gregory will deal with the important results of his recent journey, and the high plateau of Brazil by Mr. R. R. Walls. Rev. W. Weston will give a lantern lecture on the influence of geographical environment on the characteristics of the Japanese, and Prof. J. L. Myres will lecture on the Marmora region. Two joint discussions have been arranged with Section H, on the place of man and his environment in the study of the social sciences, which will be opened by Prof. J. L. Myres; and with Section L, on geography as a basis for a general science course, which will be opened by Sir Richard Gregory. Several excursions of geographical interest have been arranged, and there will be an exhibition of maps of the district prepared by members of the Liverpool Regional Survey Association.

Section G (Engineering).

The subject of the presidential address in this Section is "Transport and its Indebtedness to Science"; a new departure is being made by devoting the remainder of the morning (Friday, September 14) to papers on various branches of the same subject by experts in these several branches; Mr. Berriman, of the Daimler Co., will deal with road transport; Mr. Wall, of Liverpool, with sea transport; Mr. O'Brien, of the L.M. and S. Rly., with rail transport; and Gen. Sir Sefton Brancker with air transport.

On the morning of Thursday, September 13, Section G joins with Sections A and B in a discussion on "Cohesion and Molecular Forces." In the afternoon a joint discussion is being held with the Psychology Section on the subject of "Vocational Tests in the Engineering Trades," to be opened by a paper by Messrs. Fleming and Brocklehurst, of the Metropolitan-Vickers Electric Co.

Monday, September 17, is being devoted mainly to papers on mechanical and general engineering, while most of the papers on electrical engineering will be read on Wednesday, September 19. Tuesday morning begins with a joint discussion with the Education Section, on "The Teaching of Dynamics," opened by Sir J. B. Henderson; the remainder of the morning is to be devoted to the report of the committee on complex stresses, which includes a number of important papers by various members of the committee.

Among the papers to be read on Monday and Wednesday are the following: The conservation and control of our national water resources, by Mr. J. Parry; the recent developments in excavating machinery, by Mr. Barnes, of the Ruston Hornsby Co.; smoke abatement, by Mr. Kershaw; the electric propulsion of ships, by Mr. Clough, of the British Thomson-Houston Co.; and high-power mercury rectifiers, by Mr. Morrison. All these papers deal either with subjects of great importance at the moment or with those on which great advances have recently been made.

Capt. Slee, of the Marconi International Marine Communication Co., will describe the recent developments in the application of wireless telegraphy to shipping; and Mr. Scott-Taggart will read a paper on receiving apparatus for broadcast reception. Prof. W. M. Thornton will read a paper on the mechanism of gas ignition, and will describe a new method of lighting coal mines which greatly reduces the danger of explosion.

Dr. T. F. Wall will describe a new type of induction motor which, although of the squirrel-cage type, has many of the advantages of a slip-ring motor. Prof. Marchant will read two papers, one on a method of improving the wave-shape of an alternator, and the other on the triple-frequency currents which occur in the earth-return of three-phase cables. A paper on water turbines is being read by Dr. H. Mawson, and another on the strength of forked connecting rods by Mr. W. J Kearton.

Section H (Anthropology).

Mr. Percy E. Newberry's presidential address to the Section will be on "Egypt as a Field of Anthropological Research," and will deal with the origins of Egyptian civilisation, showing that its elements are not all native to the soil. Mr. Newberry will also deal *inter alia* with aspects of Egyptian culture in opening a discussion on "The Origin of Domesticated Plants and Animals." A second organised discussion in a joint session with the Geographical Section will deal with "The Place of Man and his Environment in Sociological Studies," to be opened by Prof. J. L. Myres. Sir Arthur Evans will embody, in a consideration of "Crete as a Stepping-stone of Early Culture," some extremely important discoveries recently made by him in that island. Mediterranean archæology will also be represented by two communications from Mr. Stanley Casson on "The North Ægean Coast in the Bronze Age" and "Prehistoric Sites in the Dardanelles and Bosporus."

In British archæology several papers will deal with Welsh prehistory, including a general survey by Prof. H. J. Fleure, and an account of "The Hill-forts in North Wales and their Historical Background," by Dr. R. E. Mortimer Wheeler. Prof. E. Ekwall, of Lund University, will discuss "The Early History of Lancashire in the Light of its Place-names."

In ethnography, Mrs. Scoresby Routledge, in "Mangarevan Folk-lore," will give an account of some results of her recent expedition to the Austral Islands and Mangareva; Mr. E. Torday will describe the methods of native traders in Central Africa, and will give an account of Hungarian folk-music, with instrumental and vocal illustrations. Mr. Torday has also arranged for a band of Hungarian gypsy musicians to perform at an evening soirée. This will give added interest to Dr. John Sampson's paper on "The Origin and Early Migrations of the Gypsies." The Near East will also be represented by Baron F. Nopsca's account of "House-building and House Implements in Northern Albania." Among a number of other interesting communications, space will permit mention only of an account of the culture of the stone-using peoples of Central Celebes by Dr. A. C. Kruyt, who has recently returned from an expedition of scientific investigation in that island.

Section I (Physiology).

The scope of Section I, comprising, as it does, physiology, histology, experimental pathology, experimental biology, and a good deal of biochemistry, is very wide, as the list of papers shows. The presidential address by Prof. G. H. F. Nuttall, on "Symbiosis in Animals and Plants," is a good example of this broad outlook. One of the most attractive items on the programme is a lecture on "Insulin and its value in Medicine," by Prof. J. J. R. Macleod, who has been closely associated with this remarkable discovery of the treatment of diabetes, made in his laboratory in Toronto by Prof. Banting and Dr. Best. On the medical side there are also papers by Dr. S. Monckton Copeman, of the Ministry of Health, on "Diet and Cancer"; by Prof. J. M. Beattie, on "The Action of Finely Divided Particles of Slate, etc., on Toxins"; by Prof. H. E. Roaf and Dr. F. W. Edridge-Green, on colour vision; and by Dr. M. C. Grabham, on "Dental Caries at Porto Santo."

The more academic aspects of physiology are represented by papers by Prof. H. Zwaardemaker of Utrecht, on "Bioradioactivity and Humoral Environment"; Prof. R. Magnus, of Utrecht, on "The Action of Carbon Dioxide and Adrenaline on the Bronchi and Pulmonary Vessels"; Prof. H. E. Roaf, on "The Analytical Mechanism of the Cochlea"; Prof. J. S. Macdonald, and collaborators, on the physiology and energetics of walking; Prof. J. S. Macdonald and Dr. F. A. Duffield, on the physiological cost of cycling; Dr. W. Waller, on the "Red Blood Corpuscles"; and Prof. C. Lovatt Evans, on the "Contraction of Plain Muscle."

The more physical and chemical side will take the form of a discussion, with the Chemistry Section, of "The Physico-Chemical Properties of Membranes in their Relation to Physiological Science," and papers by Dr. S. C. Brooks (representing the American Association) on "The Electrolytic Conductance of Micro-Organisms"; Dr. E. B. R. Prideaux, on "Membrane Potentials"; Mr. T. C. Angus, on "A Recording Katathemometer"; Prof. W. Ramsden, on "Coagulation of Albumin at Free Surfaces"; Prof. W. Ramsden and Mr. J. Brooks, on "Factors determining which of Two Liquids form the Droplets of an Emulsion"; Prof. W. Ramsden, on "Adsorption Films"; Dr. R. Coope and Prof. W. Ramsden, on clinical chemical tests; and Prof. H. E. Roaf, on "The Oxygen Content of Methæmoglobin." Some of these will be of the nature of demonstrations, and histology will be represented by a cytological demonstration by Prof. Charles E. Walker and Miss F. M. Tozer.

Section J (Psychology).

The psychological topics to be discussed this year in Section J are, in the main, similar to those presented last year at Hull. A large number of the papers have a definite and practical bearing on education and industry. Special stress is placed in several papers on the importance of individual differences. This is explicitly so in the presidential address by Mr. C. Burt entitled "The Mental Differences between Individuals—with special reference to Applied Psychology in Education and Industry."

The connexion between psychology and other sciences is again clearly shown by the titles of the joint discussions. With Section F (Economics), "The Inter-connexions between Economics and Psychology in Industry" will be discussed; and an endeavour made to study the psychological factors entering into the economic field. With Section G (Engineering), "Vocational Tests for Engineering Trades" will be described. With Section L (Education), "The Delinquent Child" will be studied—the papers dealing largely with a classification of the commoner delinquencies according to their psychological nature.

A glance at the programme shows that there are two topics of great interest both to education and to industry which receive special treatment, namely, (1) vocational guidance and vocational tests; (2) mental efficiency and fatigue. Important in this connexion will be the results presented by research workers of the National Institute of Industrial Psychology, notably in a paper on "The Conception

of Fatigue," by the director of the Institute, Dr. C. S. Myers.

In addition to the sessional programme, a series of afternoon lectures and lecturettes have been arranged; and a Citizens' Lecture entitled "Skill in Work and Play" will be given by Prof. T. H. Pear.

SECTION K (BOTANY).

This Section will meet under the presidency of Mr. A. G. Tansley, whose address will deal with "The Present Position of Botany." Most branches of botany are well represented in the programme, and, as in recent years, papers of a cognate nature will be grouped together so far as possible. The only joint discussion arranged this year is one on "Virus Diseases of Plants," in which Sections K and M will meet. This discussion will be opened by Dr. Paul Murphy, who will be followed by Prof. H. M. Quanjer, the eminent Dutch investigator of these curious maladies. One morning session will be devoted to morphological problems, including papers by Dr. D. H. Scott and Prof. Lang on the organisation of vascular plants considered in the light of fossil history. Prof. Seward will speak on the Cretaceous floras of Greenland. Plant physiology will again be strongly represented, among others, by Dr. F. F. Blackman on "Oxidation and Respiration," by Prof. Dixon on the "Extraction of Sap by means of Compressed Air," and by Prof. V. H. Blackman and his colleagues on "The Effect of Electric Currents on Plant Growth." A discussion will take place on "The Effect of Soil Sourness on Plants," in which most of the chief British ecologists will take part. There will be a considerable number of papers on cytology and mycology, also communications on floral morphology by Miss Saunders and Prof. J. McLean Thompson. In addition, a large number of papers of a miscellaneous nature will be presented. The popular lecture will be given this year by Dr. W. L. Balls on the appropriate subject of "Cotton."

Several interesting excursions have been arranged, including visits to the West Lancashire sand dunes and to Ingleborough. As in the last few years, opportunity will again be afforded for the display of botanical specimens of special interest in one of the rooms of the Section.

SECTION L (EDUCATIONAL SCIENCE).

The president of the Education Section for the meeting at Liverpool is Dr. T. P. Nunn, principal of the London Day Training College, who is taking as the subject of his address "The Education of The People"; following the examples of his two predecessors, Dr. Nunn wishes the address to be followed by a discussion, and this will be opened by Prof. Campagnac. The first paper on Thursday, September 13, will be read by Prof. O. Jespersen, of Copenhagen, a scholar of wide reputation, upon "Grammar and Logic," and a large audience is expected to hear him. The morning of Monday, September 17, will be devoted to a joint meeting of psychologists and educationists to discuss the subject of "The Delinquent Child." The chair at this meeting will be taken by Mr. C. Burt, psychologist to the London County Council and president of the Psychology Section, who has made a special study of the problem; he will be followed by Dr. Gordon, of Bath, Dr. Potts, and Miss Crossland. This discussion, which arises out of that upon psycho-analysis last year at Hull, is expected to be one of the most popular of the meeting. On the afternoon of the same day, there will be a joint discussion with the Section of Geography on geography as a basis for a general science course. The report of a committee appointed last year upon this subject will be presented.

On Tuesday, September 18, Bishop Welldon, Dean of Durham, will raise the question in a paper as to how far the value of education in elementary schools has corresponded with the increase of expenditure upon it, and it is probable that a very animated discussion will follow the paper.

During the past two years, several Sections have tried the experiment of having semi-popular lectures in the afternoons. The Education Section is following this example at Liverpool, with a paper upon "The Education of Children in Music," by Dr. C. S. Grundy, who will be assisted by a full professional orchestra, kindly arranged by Messrs. Rushworth and Dreaper, of Liverpool. There will also be a paper by Miss Margaret Einert upon "Rhythmic Dancing," illustrated by a demonstration. Each of these papers will be read at 5 o'clock, the former on the Thursday, the latter on the Tuesday afternoon.

Other topics to be considered are education and business life, the older children in elementary schools, literary appreciation in elementary schools, and the teaching of dynamics.

SECTION M (AGRICULTURE).

The meetings of Section M will be held under the presidency of Dr. C. Crowther, principal of the Harper Adams Agricultural College, whose address on "Science and the Agricultural Crisis" will be given in the morning of Thursday, September 13. Two papers from Dr. Stenhouse Williams and his co-workers at the National Dairy Research Institute at Reading will precede the president's address. After the address Mr. Hay will read a paper on agricultural economics and the development of agricultural education.

On Friday, September 14, the work of the Section will begin with two papers on frit-fly problems by Dr. Fryer and Mr. N. Cunliffe, and these will be followed by a joint discussion with Section F (Economics), in which the subject will be "The Economic Outlook for British Agriculture." The speakers in this discussion will include Mr. Forrester and Mr. A. W. Ashby.

On Saturday it is proposed to visit the Lactose Factory at Haslington, and typical cheese-making farms of that area later in the day.

The following Monday morning will be devoted to papers dealing with problems of interest from the side of physical science. The local sectional secretary, Mr. E. Rideout, will speak on the soils of Wirral, and Prof. Sven Oden, of Stockholm, on his apparatus for the mechanical analysis of soils. Different aspects of the soil water and of the soil solution will be dealt with by Mr. E. A. Fisher, of the University of Leeds, and by Prof. Hoagland and Prof. Burd, of the University of California. In the afternoon an excursion will be made to farms of the Wirral peninsula.

The concluding day of the meeting will be devoted to a discussion with Section K (Botany) on the virus diseases of plants, at which the principal speakers will be Dr. Murphy, Dr. Quanjer and Dr. Brierley, followed by a paper by Mr. G. D. Miln, of Messrs. Gartons, on the commercial value of indigenous strains of pasture grasses. Mr. Atkins and Mr. Fenton will discuss the relation of soil acidity to the natural distribution of certain pasture plants. The work of the Section will conclude with a visit to Messrs. Gartons' seed establishment at Warrington, which should form a fitting conclusion to what promises to be a sectional meeting of exceptional interest.

The Hydrogen Molecule.

By Prof. H. STANLEY ALLEN.

MODELS for the representation and elucidation of physical phenomena have played an important part in the advancement of science. Mathematicians, who employ the method known as "the ignoration of co-ordinates," may be satisfied with either a kinetic or a static model for an atom or a molecule, but the physicist and especially the chemist will, as a rule, prefer a static model. Sir J. J. Thomson[1] has done much to bridge the gap between chemistry and physics by making a serious attempt to show how, on the electronic theory of matter, atoms may be linked together to form the stable system which constitutes a molecule. To avoid the difficulties inherent in the view that the electrons are in orbital motion, he is led to postulate a more complicated law of force than that of the inverse square of the distance. For example, he considers the result of assuming a repulsion varying inversely as the cube of the distance superposed on the ordinary electrostatic attraction between a positive charge and an electron. Such a law of force may be adjusted to meet the requirements of the quantum theory. Dr. Irving Langmuir[2] has shown that a model of a static hydrogen atom may be obtained possessing many of the properties of the Bohr atom with its circling electrons, if it be assumed that, in addition to the Coulomb force between charged particles, there exists a "quantum force" given by

$$F = \frac{1}{mr^3}\left(\frac{nh}{2\pi}\right)^2,$$

acting between an electron (mass m, charge e) and a nucleus. In this formula n is an integer, and h is Planck's constant. When the electrostatic attraction, e^2/r^2, between electron and nucleus is balanced by the repulsion due to the "quantum force," the stationary electron is in stable equilibrium at a distance from the nucleus $r = a_n$, where

$$a_n = \frac{1}{me^2}\cdot\left(\frac{nh}{2\pi}\right)^2,$$

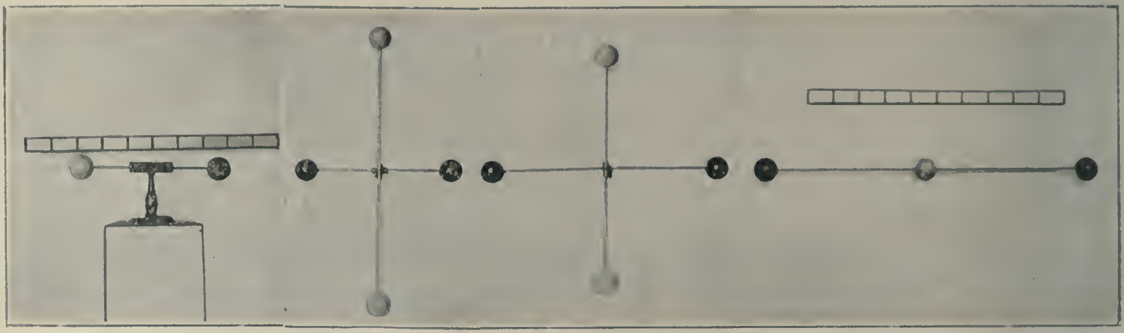
which is the radius of a circular orbit in Bohr's theory of the hydrogen atom. When $n = 1$, we obtain the normal hydrogen atom represented in Fig. 1 (a), in which the black ball stands for the positive nucleus, or "proton," the white ball for the negative electron. The scale above the model represents one Ångström unit, that is, the one hundred millionth part of a centimetre. The distance between the centres of the spheres is 0·531 Å.U., with an error of perhaps one or two units in the third significant figure. No physical meaning is to be attached to the size of the spheres themselves.

In a paper published by the Physical Society of London[3] the writer has pointed out that a force of exactly the type required in Langmuir's theory is provided by the quantum mechanism described by Prof. E. T. Whittaker.[4] Thus a static atom may be obtained by transferring the motion of the electron in Bohr's atom to the rotation of a "magnetic wheel" in the quantum mechanism. The question then suggested itself whether it might not be possible to obtain a static model of the hydrogen molecule by endowing the nucleus or the electron with a magnetic wheel. After considering various possible cases of this kind which gave models not differing greatly in scale from what might be expected on experimental grounds, it appeared that the simplest and probably the most accurate results were obtained by postulating the existence of a "quantum force" of the kind introduced by Langmuir, but exerting repulsion or attraction according to the sign of the electrical charges between which the force acts. It will, then, be assumed that in addition to the electrostatic force, e^2/r^2, between elementary charges, there exists a "quantum force"

$$F = e^2 \cdot \frac{a_n}{r^3},$$

which is repulsive for unlike charges, but attractive for like charges.

Before considering the configurations obtained on this basis, it will be well to recall the model of the hydrogen molecule devised by Prof. Bohr. This is represented in its most stable form in Fig. 1 (b) on the same scale as was employed for the hydrogen atom. The two electrons (white balls) spin round in a circular orbit in a plane bisecting at right angles the line joining the hydrogen nuclei. The electrons, which are always at opposite ends of a diameter of the circle, have each an amount of angular momentum, $nh/2\pi$, determined by Nicholson's quantum condition. It is easy to show that an electron must be at the vertex of an equilateral triangle having as its base the



(a) Hydrogen atom. (b) Hydrogen molecule (Bohr). (c) Hydrogen molecule (static model). (d) Charged hydrogen molecule.

FIG. 1.—Models representing the hydrogen atom and molecule. Black balls represent the positive nuclei and white balls the electrons; scale above the models = 1 Å.U. (0·00000001 cm.).

[1] *Phil. Mag.*, vol. 41, p. 510, 1921.
[2] *Phys. Rev.*, vol. 18, p. 104, 1921.
[3] Proc. Phys. Soc., vol. 34, p. 198, 1922.
[4] Proc. Roy. Soc. Edin., vol. 42, p. 129, 1922.

line joining the nuclei, the length of the base being $1 \cdot 1007 a_n$.

It is generally admitted that while the Bohr atom is able to account quantitatively for the phenomena associated with it, the Bohr molecule is far from satisfactory. If a "quantum force" act between each pair of the four electric charges which constitute the neutral molecule, it is possible to replace Bohr's model of the hydrogen molecule by a model with the electrons at rest relatively to the hydrogen nuclei. Various configurations of equilibrium are theoretically possible, but not all of these are stable. The most stable configuration, from the point of view of ordinary statics, appears to be that in which the nuclei and electrons are situated at the corners of a square, with the nuclei at the ends of one diagonal and the electrons at the ends of the other. The length of a diagonal is $1 \cdot 6407 a_n$. When $n=1$, the length of a diagonal is 0·871 Ångström units, and this case is illustrated in Fig. 1 (*c*). Another configuration agrees exactly with that obtained from Bohr's theory and is shown in Fig. 1 (*b*), but the electrons are now at rest instead of in circular motion. In a third configuration, the positions of the charges are similar but the positions of the black and white balls must be interchanged.

It is possible that such configurations might exist for a time side by side, and such a possibility is suggestive in connexion with the varied values sometimes found in determinations of ionisation potentials. When collisions between gaseous molecules are taken into consideration, it is not easy to say what would be the most probable configuration in the final distribution. It is certainly instructive to find such a possibility of different configurations in the case of the simple hydrogen molecule, and points to the necessity of guarding against too rigid an interpretation of the phrase "gaseous molecule" in speaking of more complex gases, whether elements or compounds.

The actual existence of a positively charged hydrogen molecule is demonstrated in experiments by Sir J. J. Thomson and Dr. Aston. On the present hypothesis a stable configuration is obtained by placing the single electron at the middle point of the line joining the atomic nuclei. In the one-quantum state the distance between the nuclei is 1·239 Å.U., as in Fig. 1 (*d*). The ionisation potential for the complete dissociation of the charged molecule is 17·34 volts as against 11·87 volts on Bohr's theory. This should serve to discriminate between the two theories.

A possible configuration may be suggested for a neutral triatomic hydrogen molecule, H_3, in which the nuclei and electrons are situated at alternate corners of a regular hexagon (length of side, 0·625 Å.U.).

Some of the more important numerical data are collected in the following table; full details will appear in a paper in course of publication in the Proceedings of the Royal Society of Edinburgh.

TABLE I.

	θ.	d_1 (Å.U.).	$I_1 \times 10^{41}$.	W (volts).
Neutral hydrogen molecule	45°	0·871	6·261	30·06
	60°	$0 \cdot 584_5$	2·818	29·68
	30°	1·012	8·453	29·68
Ionised molecule		1·239	12·66	17·34
Triatomic molecule			9·726 19·452	46·25

θ = angle between the line joining nucleus and electron and the line joining nuclei.
d_1 = distance between the nuclei in the one-quantum state.
I_1 = moment of inertia in C.G.S. units for the one-quantum state.
W = work required for complete dissociation expressed in equivalent volts.

The ionisation potentials calculated from the values of W in the table are in moderately good agreement with the experimental results. A more exacting test of the accuracy of such a model is to be expected from a study of the wave-lengths of lines in the secondary spectrum of hydrogen. Even though the numerical values quoted may have to be modified, it may be claimed that it is now possible to postulate a hydrogen molecule in which the electrons are at rest instead of in orbital motion. It is obvious that the principles here employed may be applied to more complex atomic and molecular systems.

The Liverpool Observatory (Bidston).

AFTER a career of eighty years, during which the Liverpool Observatory has fulfilled the purpose for which it was designed, the Mersey Docks and Harbour Board, which is responsible for its support and management, has decided that the time has arrived when the usefulness of the institution might be increased by directing its energies into channels additional to those originally contemplated. It may be recalled that the chief objects sought in establishing an Observatory in Liverpool were the communication of accurate time to the Port and the rating of chronometers. The action of the British Association at the Liverpool meeting in 1837 contributed largely to the adoption of the necessary measures; the meeting in 1923 might give similar encouraging support to the widened programme now under consideration.

The Mersey Docks and Harbour Board considers that the facilities which the Observatory affords for the advancement of knowledge and diffusion of science and learning might be increased if a closer union could be established with the University. As a preliminary measure, it is suggested that the future administration and working of the Observatory may be advantageously entrusted to a joint committee of the Board and University, each nominating five members. This joint committee has now been appointed, the Board's representatives being Mr. C. Livingston, Mr. H. F. Fernie, Col. H. Concanon, the Marine Surveyor and Water Bailiff, the director of the Observatory; and the University nominees, Mr. C. Booth, Prof. Johnstone, Prof. Proudman, and Prof. Wilberforce.

The Dock Board and the University are actuated by a desire to effect an intimate connexion between the recently constituted Tidal Institute, the Observatory, and the department of the Marine Surveyor. The meteorological statistics collected by the Observatory are useful in extending the researches of the Institute in particular directions, while the tidal measurements conducted by the Marine Surveyor afford the necessary means for testing the accuracy of prediction. This closer co-operation has the additional advantage of removing the inconvenience of overlapping.

By utilising the existing establishment as the nucleus of a geophysical observatory, teaching could be combined with research—an extension which is not only feasible but eminently desirable. None of the past activities need be abandoned. The scientific centre would be maintained unimpaired, and its traditions continued. The greater activity exhibited, and the execution of an enlarged programme arranged

to meet modern requirements, should appeal to the intelligence of a progressive community. Meteorology would be followed on extended and more original lines. Magnetic observations, which unfortunately have never formed a part of the Observatory work, would be actively pursued, and the inconvenience occasioned by the want of accurate magnetic constants removed. The attention already given to seismometry could be increased with advantage. Classes are now held in practical surveying and geodesy, and these, at present hampered by want of room and convenience, could be more fittingly accommodated.

There is a difficulty in finding the necessary funds, especially at this juncture, but if a judicious programme is submitted to the attention of those capable of carrying it into execution, the past history of Liverpool leads one to anticipate that even this obstacle will not be found insurmountable.

The Eleventh International Physiological Congress.

NATIONAL congresses of a general scientific character, like the British Association, have been held in various countries for about a century, but international meetings, limited to a particular branch of science, present greater difficulties, and are of more recent date. The disruptive effect of the Franco-Prussian war was long felt, and the meetings of physiologists, started on the initiative of Michael Foster thirty-five years ago, were at first anxiously confined to the smaller countries, like Switzerland and Belgium. In 1898 a Physiological Congress met at Cambridge, but no meeting took place in Germany until that at Heidelberg in 1907. After Vienna in 1910 and Groningen in 1913, Paris was chosen as the next meeting-place, but the regular succession was broken by the War. The Paris congress was indeed held in 1920, but some nations, who have contributed much to physiology, were not represented. As Prof. J. E. Johansson said in an impressive speech at the closing meeting of the congress held at Edinburgh on July 23-27, many will feel grateful to its president, Sir Edward Sharpey Schafer, for the return to an earlier tradition. It was, indeed, the truly international character of the Edinburgh meeting which contributed largely to its success. For successful it certainly was, both as regards scientific interest and personal relationships. Some twenty nationalities were represented, doubtless a record for physiologists and for Scotland, if not for Britain. The membership of 460 exceeded that of the very successful Groningen meeting (if ladies, not engaged in physiological studies, be deducted).

As regards the programme, the customary informal reception was held on the Monday evening, by Sir Edward and Lady Sharpey Schafer, in the Old College of the University. At the opening meeting on Tuesday morning, July 24, addresses of welcome were delivered by Capt. Walter E. Elliot for the Government, by the Rt. Hon. Sir Thomas Hutchison, Lord Provost of the City, and by Sir J. Alfred Ewing, Principal of the University; Prof. J. J. R. Macleod, of Toronto, delivered a lecture on insulin. Then followed a panoramic photograph of the whole congress. The Lord Provost and Lady Hutchison held a largely attended reception in the evening, and two days later the Congress visited the Scottish Zoological Park; for the rest it was occupied with a crowded scientific programme of about 200 communications, which were given concurrently in three lecture rooms, with additional laboratory demonstrations in the afternoons.

The so-called New University Buildings, which mainly constitute the Edinburgh Medical School, were not planned very satisfactorily, and are not entirely up-to-date, but they possess at least one advantage: they form a compact whole round a central quadrangle, and this feature was of great value for a meeting like the present one. The lecture rooms and other resources of several contiguous departments were simultaneously available. An indicator in each lecture theatre, kept continuously up-to-date, announced what papers or experiments were in progress in the other rooms. Occasionally the communications and their polyglot discussion took more than the 15 minutes allotted to each, and not all the 36 chairmen were sufficiently strict, but in the end the programme was completed without serious delay.

In addition to the opening lecture on insulin, by Prof. J. J. R. Macleod, two other addresses were given to the whole congress. Prof. Ch. Richet, of Paris, spoke on "Les voies de la connaissance autres que les voies sensorielles; étude de physiologie expérimentale," and at the closing meeting a paper by Prof. I. P. Pawlow, of Petrograd, on "The Identity of Inhibition, as a Constant Factor in the Waking State, with Hypnosis and Sleep," was read in English by his son, Prof. W. Pawlow. On the conclusion of this paper, describing recent experimental work on conditioned reflexes, the enthusiastic audience rose to its feet to applaud the veteran physiologist, whose participation in the congress was almost prevented by the refusal of a British *visa* on leaving New York. Permission to land at Southampton (instead of Cherbourg) was, however, obtained by wireless telegraphy during the voyage, through the enterprise of an American colleague and fellow-passenger, who communicated with an English physiologist.

At the closing meeting an invitation to meet in America was conveyed by Prof. A. J. Carlson, of Chicago, as president of the American Physiological Society, and an international committee was appointed to consider the possibility of accepting it, and should the economic obstacles prove too great, to select another place for the meeting in 1926.

It is naturally difficult to single out, for individual mention here, a few of the numerous communications, abstracts of which were issued in advance, arranged alphabetically in book form. They will appear later as a supplementary number of the *Quarterly Journal of Experimental Physiology*. On the first afternoon the section dealing with insulin attracted the largest audience; here F. G. Banting and C. H. Best, of Toronto, reported that they had found insulin in normal rabbit's blood, one unit for about 30 c.c. In the vitamin meeting, held at the same time, it was evident that the subject is attracting more and more attention on the continent. K. Hotta, a Japanese investigator working at Frankfort, described how the characteristic convulsions of pigeons, fed on polished rice, may be entirely prevented by feeding with cholesterol. In yet another section W. R. Hess, of Zürich, reported on the plans for founding a station for high altitude research near the terminus of the Jungfrau railway (about 11,500 feet above sea-level). The peculiar advantage of this site is its ready accessibility, as compared with the Mosso laboratory on the Monte Rosa, which can only be reached with difficulty and during a very limited period of the year; 120,000 francs have already been subscribed, and a further sum of 100,000 francs is considered necessary. This Swiss station is not intended

only for biological work, but also for meteorology, climatology, astronomy, etc.

Among the demonstrations, one by A. N. Richards and J. T. Wearn, of Philadelphia, attracted much attention. They showed how to collect glomerular filtrate by insertion of a very fine capillary into Bowman's capsule in the frog. The crowded laboratory must have increased the difficulties of this very delicate operation. Prof. Richards subsequently explained how the minute volume of fluid was analysed by the nephelometric methods of his namesake, the chemist. The filtrate is rich in chlorides which must be re-absorbed in the tubules, and hence a decision is arrived at with regard to rival theories of urinary secretion. Similarly, Bloor's nephelometric phosphorus determination, modified by H. Winterstein, of Rostock, enabled the latter to investigate the phosphorus metabolism of the central nervous system of the frog; the phosphatides here play a considerable part.

H. J. Hamburger and R. Brinkman, of Groningen, claim that the nervous stimulation of the heart sets free substances which influence the contraction of the stomach and gut in the same way as if the nerves of these organs are stimulated electrically; they term this humoral transmission of nervous impulses.

Papers of methodological importance were communicated by A. Kossel, of Heidelberg, who has discovered in the dinitronaphtholsulphonic acid of naphthol yellow a reagent for the quantitative precipitation of arginine and for the isolation of many other bases, and by E. London, of Petrograd, who described a new method for investigating intermediate metabolism, consisting in the introduction of permanent metal cannulæ into deep-seated abdominal blood vessels.

Owing to the circumstance that a conference on the physiological standardisation of drugs met under the auspices of the League of Nations at Edinburgh just before the congress, pharmacology was well represented. At the congress, J. J. Abel and C. A. Rouiller, of Baltimore, described the further purification of the oxytoxic principle of the pituitary, which they have now obtained as a substance which is 1000-1250 times as active as histamine phosphate on the guinea-pig's uterus; the product also possesses powerful pressor and diuretic properties.

W. E. Brown and V. E. Henderson, of Toronto, find that ethylene will produce complete surgical anæsthesia, being more potent and in other ways preferable to nitrous oxide.

During the congress a number of important cinematographic demonstrations were given; perhaps the most interesting was by A. Krogh, of Copenhagen, which showed, under great magnification, the effect of various agents on capillary circulation (this film should prove of immense value in teaching large classes).

In connexion with the congress a Harvey medal, the work of Mr. Pilkington Jackson, the Edinburgh sculptor, was given to every member, and the University of Edinburgh conferred honorary degrees on eight distinguished foreign physiologists who were present, namely, Prof. F. Bottazzi, professor of physiology, University of Naples; Prof. W. Einthoven, professor of physiology, University of Leyden; Prof. W. H. Howell, professor of hygiene, Johns Hopkins University, Baltimore; Prof. J. E. Johansson, professor of physiology, University of Stockholm; Prof. A. Kossel, professor of physiology, University of Heidelberg; Prof. H. H. Meyer, professor of pharmacology, University of Vienna; Prof. I. P. Pawlow, professor of physiology, University of Petrograd; and Prof. Ch. Richet, professor of physiology in the Faculty of Medicine, Paris.

A Seventeenth Century University of London.

EVERY one knows that London was the last great capital city to be provided with a University. The reason for this is not obvious, but the fact remains that after the failure of Sir Thomas Gresham's great aspiration in the seventeenth century, the mere idea of a University seems to have been dropped until it was revived by the Benthamites in the nineteenth century. But not altogether: a solitary enthusiast now and again raised his voice. In 1647 there was a curious proposal launched in a pamphlet, now extremely rare, for remedying this deficiency. The proposal came to nought, like many educational projects, not only, we may surmise, because the country was in the grip of the Civil War, but, as will appear, by reason of certain difficulties inherent in the scheme. The title of the tract, or rather part of the title—for it is a true child of the seventeenth century, when long titles were the vogue—is "Motives grounded upon the Word of God, and upon Honour, Profit, and Pleasure for the present Founding an University in the Metropolis London, . . ." and the author chose to be known as "a True Lover of his Nation, and especially of the said City."

The True Lover is manifestly a Puritan, and his main concern is with the shortness in the supply of preachers of whom he estimates that we want more than 20,000, "and are hopeless of supply, without other provision than yet we have." The old universities, even at their prime, could not bring forth such numbers. Now was the golden opportunity for London to remedy this lamentable defect "when so many great houses may be had and made Colleges of, with so little alteration, and Pauls Church and London-House be the publike Schooles." Teachers were to be had on as easy terms as buildings: "by reason of the Warres in other Countries, you may now have the choicest of their Professours of the Arts."

But the True Lover's financial plan displays greater optimism than knowledge of human nature warrants. If every sincere Christian in London gave up one meat meal a week it would be possible to maintain, he thinks, twenty thousand "poore Schollars," and a similar abstention throughout the Kingdom an hundred thousand. This greater number by no means dismays the True Lover; on the contrary, it stirs his enthusiasm. After a general course of military training, twenty thousand of the "choycest" would be selected as ministers, the remainder being "imployed in Trades, or Navigation and show themselves for the defence of this country Lions on the Land, and Dolphines on the Seas." The elect would also "Discipline their Parishes and put all England in Israels posture so that we might be a Nation of Souldiers and defend our Religion both with Divine arguments and (if need required) with corporall Armes also."

If the True Lover had read Milton's famous Tractate on Education, published three years earlier, he had not been impressed by it, nor had he apparently breathed any of the ideas which were a few years later to bring about the first meetings of the nascent Royal Society. His notions of curricula may be described as humanistic, coloured with a pronounced utilitarianism. Three colleges were to house the hundred thousand. In one nothing but Latin was to be spoken, and in two years the scholars would thus be able to speak as good Latin as they do English. "How easily afterwards," he exclaims, "would they

attaine the Italian, French and Spanish Tongues, and in Merchandizing be fit to negotiate with the greatest Princes." In a second College nothing would be spoken but Greek, and in a third Hebrew. This would attract all " forraigne Protestants of work in this westerne World," as well as the Jews " whose conversion is now at hand."

The vision of a truly Puritan Paradise opens up. " If London were an University, such, pluming the Crest of this Royall City, would cause it to present a more glorious aspect than all the lofty Cypresses in Constantinople doe unto all that approach unto it: yea, all the yeare long cause London to resemble Jerusalem in the Feast of Tabernacles." Not only would there be a chaplain in every house of the nobility (and even " the Citizens carry one sometimes "), but every godly merchant might have a graduate in his ship, and " Sea-men (generally so prophane) " might become Saints and " their masters goods prosper in their hands."

That there will be objections from Cambridge and Oxford (the order of precedence is his and prompts a conjecture as to the True Lover's upbringing) is foreseen, but these, it can well be imagined, do not daunt such a buoyant optimism. Your True Lover, if he is worthy of the name, has as little difficulty with objections as with finance. Thus there are nine answers to the three objections (" weak, weaker, weakest "), not any of which are objections founded upon such base things as accommodation and finance. Perhaps, however, it was this sort of objection which prevailed with the Lord Mayor and his colleagues (to whom " Motives " are presented), and, as we know, the True Lover's University did not build Jerusalem in London. Which, perhaps, is just as well.

E. D.

Immigration and Degeneracy in the United States.[1]

THE United States Government is taking measures to control immigration, so as to ensure, so far as is possible, that undesirables of all sorts shall be excluded. The present publication, which is the statement of Dr. Harry H. Laughlin made before the Committee on Immigration and Naturalisation of the House of Representatives, is witness to its activity in this direction. By estimating the actual and predicted proportions of various sorts of degeneracy contributed by the various stocks that enter the United States, it is possible, by excluding immigrants from those foreign countries that contribute more than their share, to ensure that the healthiest possible stocks only are admitted.

The statement of Dr. Laughlin covers feeble-mindedness, insanity, criminality, epilepsy, inebriacy, leprosy, tuberculosis, blindness, deafness, deformation, and dependency. It is found that each of these forms of degeneracy demand distinct methods of treatment. For example, it is comparatively easy to control feeble-mindedness, for it manifests itself early in life. Therefore it is found that the native white population contributes, proportionally, more than the immigrant white to the feeble-minded part of the population. On the other hand, insanity, which manifests itself much later in life, is not so easy to diagnose in the immigrant, with the consequence that the immigrants of the present generation have a higher incidence of mental instability than is possessed by the foundation families. Therefore it is proposed that immigrants should come of families with no record of insanity.

The case of crime is interesting. Those countries that have contributed least to the criminal population of the United States are Great Britain, Scandinavia, Ireland, Germany, and the Netherlands; *i.e.* precisely those that have contributed the foundation stocks. The Southern European countries have contributed a far larger proportion, and this is probably due, in the opinion of Dr. Laughlin, to a change in social environment, with a consequent social maladjustment. Since criminalistic tendencies show themselves early in life, it has been possible to exclude this type with a considerable degree of success.

The analysis of figures has made it possible to reach some interesting conclusions with regard to the contributions to degeneracy made by the different constituent elements of the population of the United States, and it is evident from this report that before long we shall know much more than we do at present about the problem of degeneracy. One definite conclusion seems to have been reached by Dr. Laughlin; he states that " custodial inadequates are for the most part recruited from a relatively small portion of the families of the whole population. This means that social inadequacy is not a result of accident or bad environment, but that primarily most custodial inadequacy is founded upon degenerate inheritance."

The ultimate effects of the prosecution of a thoroughgoing policy of immigration control will be far-reaching; for the United States will be able to absorb the healthy stocks, and to reject the unhealthy, thus greatly benefiting itself at the double expense of European countries.

W. J. PERRY.

[1] Analysis of America's Modern Melting Pot: Hearings before the Committee on Immigration and Naturalisation, House of Representatives, Sixty-seventh Congress, Third Session, November 21, 1922. Statement by Harry H. Laughlin. (Serial 7-C.) Pp. 723-831. (Washington: Government Printing Office, 1923).

Fire Hazards and Fire Extinction on Oilfields.

THE subject of fire-risk, prevention and extinction on oilfields is one which the public as a whole tends to take very much for granted, only being stirred to interest by press reports of oil-well fires such as occurred in Trinidad some two years ago, when thousands of pounds' worth of damage was done, or by more serious disasters on some of the American fields, involving the loss of many lives. On the other hand, those concerned with the actual control of oilfields, if not the employees themselves, are very much alive to the ever-present danger of a conflagration arising from the high degree of inflammability of petroleum and its products, and they know, usually only too well from experience, that oil-fires, from the inherent nature of the materials involved, are by far the most difficult to combat successfully.

Prof. J. S. S. Brame chose this subject as the theme of his valedictory address to the Institution of Petroleum Technologists recently, and in view of the rapid and generally unappreciated evolution of modern methods of oil-fire extinction, especially as practised in America, his dissertation was particularly welcome. It certainly stimulated members of his audience to a keener perception of the risks run by those engaged in all branches of the industry, without in any sense being either sensational or alarming.

As with other undesirable evils, prevention being better than cure, the greatest possible care is taken nowadays to meet, by precautionary measures, the contingencies of oil-well and oil-tank fires. Unfortunately, one of the chief causes, lightning, is extremely

difficult to safeguard against, and the loss of oil by ignition of the associated gases during storms is a formidable problem, especially in certain parts of the United States. In the Mid-Continent field, for example, as much as 1,000,000 barrels of oil per annum has been lost in this way.

Preventive measures consist for the most part in the employment of specially designed storage tanks, the wooden top surmounting the metal body being a favoured form in America. This type of tank is open to the objection that continuity of metal is broken, so that perfect protection from lightning cannot be assured. In this country, all-metal tanks are preferred; sometimes steam-lines are led to the tops of the tanks for discharging steam freely at the approach of a thunderstorm, though in the case of large tank-farms the method proves impracticable. Tanks are usually built in the centre of sump-holes, while a clearance of 200 feet between the site of each tank is desirable. Probably the most recent method for preventing oil-tank fires is that concerned with the use of "Sealite," an artificial preparation consisting of a mixture of glucose, glycerin, calcium chloride, glue and starch. This mixture can be rendered lighter than oil by aeration, and when pumped into the tanks it floats on the oil, thus preventing evaporation and also combustion. The better-known "Foamite-Firefoam" system of fire-extinction is only applicable once a fire has started; this depends on the foaming reaction set up by bringing together alum and licorice, by which carbon dioxide is generated, thus effectively choking the fire.

Oilfield fire may of course be due to other causes besides lightning; the friction of the crown-pulley when bailing operations are in progress on the rig; crossed guy-lines or wires causing sparks which ignite the volatile gases; the throwing down of lighted cigarette-ends (regarded as a criminal offence in some countries—and rightly so); spontaneous combustion of gas-lines; leaky pipe-lines; all these contribute to the possible risks to be guarded against.

A somewhat novel and generally unsuspected cause of petrol-fires is the power which the mobile spirit has of generating static electricity. Ignition of volatile oils through static discharge has been known in hairdressers' shops, in garages where men have chanced to clean their hands with silk rag soaked in petrol, in filling up petrol tanks of motor cars using a piece of chamois leather for filtration purposes. A still more curious case is that of the chauffeur who was drawing from a self-measuring tank into a can bearing a wooden handle; he hung the can by this handle, thus insulating the receptacle, and under these conditions the oil caught fire on two successive occasions.

The moral of these examples is obvious. They serve to show, however, the meticulous care necessary in handling petroleum under all conditions, and it speaks volumes for the administrative and technical ability of those responsible for storage and distribution of oils, that the disasters attending oil-fires are so few, not only in Great Britain but also in America, where such vast quantities of inflammable spirit are dealt with annually.

H. B. Milner.

The Greenwich Magnetic Observatory.

Proposed Removal to Holmbury Hill.

Magnetic observations were commenced at the Royal Observatory, Greenwich, in the year 1840. They included absolute observations of the magnetic elements together with eye-observations, obtained at first every two hours and afterwards every hour, for determination of the variation of the elements. In 1847, continuous photographic records of the elements were introduced and have been continued until the present time. The length of this continuous series of observations provides valuable material for the study of the phenomena of terrestrial magnetism. It was by their means that Mr. Ellis demonstrated the 11-year periodicity common to the variations in the diurnal ranges of the magnetic elements and to the sun-spot period, and that Mr. Maunder established the connexion between the recurrence of magnetic storms and the rotation of the sun. More recently, Dr. Chapman, by using the Greenwich observations, combined with similar records of one or two other observatories which have a long series, has been enabled to put forward a comprehensive theory connecting magnetic storms and the regular diurnal variations of the elements with the electrification of and movements in the atmosphere, caused by the discharge from the sun of electrified corpuscles. The Admiralty magnetic charts are constructed at Greenwich, the last issue in 1922 consisting of three large-scale maps showing the magnetic variation, and three smaller maps showing the magnetic variation, dip, and horizontal intensity for the whole world.

During the last twenty years the magnetic observations have all been transferred to buildings constructed of non-magnetic materials in a special enclosure in Greenwich Park away from the iron in the Observatory. The instruments have also been modified and improved. With the growth of electric traction in the latter part of the last century, steps had to be taken to safeguard the Observatory from disturbances due to leakage currents. Since 1903, a protective clause has been inserted in all Parliamentary Bills for electric rail- or tramways running within five miles of Greenwich, and a clause requiring insulated returns if running within three miles. With these safeguards, the disturbances, though perceptible, have been kept within reasonable limits.

On the decision of the South Eastern and Chatham Railway Co. to electrify its local services which run in the near vicinity of, and on both sides of, the Observatory, the question of safeguarding the interests of the Observatory was taken up with the Ministry of Transport. It was ultimately agreed that the most satisfactory arrangement for both parties, and the cheapest for the railway company, would be to move the magnetic observatory to another site, the railway company defraying the costs of the removal and the extra cost of maintenance thereby involved. A site near London was desirable, not only so that supervision from Greenwich would be easy, but also in order to maintain a first-class magnetic station in the south-east of England. After examination of all sites within fifty miles of Greenwich which were at least three miles from any existing railway, the region which seemed to offer least probability of being affected in the future by railway extensions or building operations was that around Holmbury St. Mary in Surrey. The site finally chosen as the most suitable in the neighbourhood is on the lower slopes of Holmbury Hill.

Some opposition has been aroused owing to it being common land. The buildings to be erected on it would be low and not unsightly, and would not interfere with the amenities of the district. The fact of being on common land would, on the other hand,

afford a guarantee against disturbance by possible future building operations. The Admiralty has undertaken to meet the wishes of the Commons and Footpaths Preservation Society by acquiring an equal area of land adjacent to the common and adding it to the common so that the total area of the common will not be reduced.

Academic Biology.

UNDER the title "The Dry-rot of our Academic Biology," Prof. W. M. Wheeler delivered a most provocative address to the American Society of Naturalists, which is printed in *Science* (vol. 57, pp. 61-70). The address may have been written under the reaction from the author's labours upon a volume of 1100 pages upon ants, but it provides food for thought for the teacher of biology. The title seems to have been chosen in part with an impish desire to lead the librarian astray, so that future students of the fungi may find it "reposing unashamed between such monuments of cryptogamic erudition as the 74 folio volumes of Professor Farlow's 'Toadstools of God's Footstool' and the 27 quarto volumes of Professor Thaxter's 'Laboulbeniales of the Universe'"; in part to indicate Prof. Wheeler's foreboding as to the devastating effect of academic biology upon the young minds exposed to the danger.

Apparently 25 per cent. of the young men and women graduating in the United States have had at least the equivalent of an elementary course in botany or zoology, but of these very few exhibit a vital and abiding interest in biological inquiry. This seems to have led to this interesting analysis of the relative ineffectiveness of biological teaching (tinged, perhaps, with the after effects of eleven hundred pages upon ants!). Some of the suggested defects will certainly provoke sympathetic response in Great Britain, for instance the complaint that biologists are compelled to be most active pedagogically during the annual "glacial period," with a consequent reliance upon preserved material of convenient types and a great restriction of field studies. The mature student who, after four years in a divinity school, relinquished attendance upon a course in genetics because the professor's mental processes were so similar to those of his divinity teachers when they held forth on predestination, salvation through grace, etc., is cited as part of a general indictment which suggests the reflection that the best culture medium for the academic dry-rot fungus consists of about equal parts of narrow, unsympathetic specialisation, and normal or precocious senile abstraction. There are redeeming features, however, and the author rejects a friend's remedial proposal that staffs should be completely changed and buildings burnt out or thoroughly disinfected every 25 years! Another tendency which is deplored is the migration of the American graduate to the German laboratory and the teaching of authority, instead of spending the few precious post-graduate years among the problems provided at her door by the flora and fauna of the tropics.

Two positive suggestions for improvement are made: first, that teaching should be more ecological in a very wide sense of the term, and botany is certainly moving very rapidly in this direction in Great Britain; secondly, that opportunities should be provided for the amateur naturalist to meet the young student both in the laboratory and in the field, and so counteract the paralysing influence of academic formalism by his unprofessional enthusiasm and interest.

University and Educational Intelligence.

LONDON.—The work of the Ramsay Memorial Department of Chemical Engineering at University College will begin in October. The department has been instituted with the object of enabling young graduates in chemistry and engineering, who have already obtained a good training in the fundamental sciences of chemistry, physics, and mathematics, to direct their studies and investigations towards the application of the principles of physical chemistry to the scientific design and operation of the apparatus and processes of chemical industry in general. Mr. E. C. Williams, of the University of Manchester, has been appointed professor in charge of the department. An assistant lecturer, who must have had an engineering training, will shortly be appointed by University College Committee.

THE Folland scholarship in metallurgy, in connexion with the University College of Swansea, is to be offered in competition on September 10 and following days. The scholarship is of the annual value of 50*l*., and tenable for three years. Further particulars are obtainable from the Registrar of the College.

A LIMITED number of grants in aid to junior assistants in chemical works and laboratories in or near London, desirous of extending their knowledge of chemistry, will shortly be allocated by the committee of the Salters' Institute of Industrial Chemistry. Applications must be sent before September 15 to the director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4.

APPLICATIONS are invited by the Royal College of Physicians of Edinburgh for the Parkin prize, value 100*l*., which is open to competitors of all nations, for the best essay on "the curative effects of carbonic acid gas or other forms of carbon in cholera, for different forms of fever and other diseases." Competing essays, which must be written in English, must reach the Secretary of the College not later than December 31 next, bear a motto, and be accompanied by a sealed envelope bearing the same motto outside, and the author's name inside. It is stipulated that the successful candidate shall publish his essay at his own expense, and present a printed copy of it to the college within the space of three months after the adjudication of the prize.

MUCH of the scientific information latent in government publications fails to reach those to whom it would be of the greatest utility. An example of how such information can be made more generally accessible is the index issued by the United States Bureau of Education to documents having a bearing on the subject of home economics. This (revised March, 1923) includes not only 55 of the Bureau's own pamphlets, but several hundreds of others issued by the Department of Agriculture, the Bureaus of Standards, of Mines, and of Fisheries, the Labour Department Children's Bureau, the Public Health Service, the Federal Board of Vocational Education, and the American Red Cross.

"THE janitor of a modern school building is, next to the principal, perhaps the most important officer in the school." This pronouncement by Dr. Dresslar, an American authority on school hygiene, is quoted with approval by the author of "The School Janitor: a study of the functions and administration of school janitor service," Bulletin, 1922, No. 24 of the United States Bureau of Education. The writer goes on to show that although the average annual salary of school janitors is 980 dollars, or more than 50 per cent.

higher than that of elementary and high-school teachers, including principals, most people fail to realise the importance of this service or, indeed, to give the subject any thought at all, with the result that most janitors are selected and appointed for personal or political reasons rather than on the basis of merit, and many are incompetent and physically, mentally, and morally unfit. In view of the large control exercised by them over health conditions, especially as regards cleanliness, air, and light, their moral influence, and the high importance of their work educationally as setting standards of housekeeping and taste, and financially as affecting the preservation of valuable property, it is surprising that this is the first comprehensive study of the subject that has been published in America.

THE teaching of civics and the encouragement of activities making for good citizenship have received a large and increasing amount of attention in the United States since the War. Numerous pamphlets and leaflets issued by the Bureau of Education on "lessons in civics in the elementary grades," "preparation of teachers of the social studies for secondary schools," boy-scouts and girl-scouts, "lessons in community and national life," "Americanisation," "the teaching of civics as an agency for community interest and citizenship" (by the Commissioner of Education), etc., have recorded and stimulated the movement. The last of the series is Bulletin, 1922, No. 45 on "Status of certain social studies in high schools." This gives the results of an investigation conducted by the Bureau in 1922, and compares them with the facts revealed by a similar inquiry in 1919. Important changes have developed in the treatment of civics and economics in the schools, the tendency being to make the courses more practical and to deal with modern social and economical problems instead of merely with the machinery of government and economic theory. Of the 13,000 largest high schools of the country to which a questionnaire was sent in 1922, half sent replies, and of these 88 per cent. offer instruction in civics, most of the courses being obligatory, and 41 per cent. offer courses in economics, more than one-third of which are obligatory.

SOME recent developments in educational journalism are described by Prof. Carson Ryan of Swarthmore College, in Bulletin 25 of 1923 of the United States Bureau of Education. The technical educational journals have been hard hit by the rise in costs of production and have with difficulty held their own. Of the 144 journals listed in the bulletin not more than 10, with an aggregate circulation of less than 40,000, attempt to deal with educational problems in a national way free of associational connexions. Forty-eight State and associational periodicals have an aggregate circulation of 234,800. They include the Journal of the National Education Association, which in less than two years has attained a circulation of 130,000. Educational journalism in the daily newspapers has maintained itself effectively and improved in quality. Although the daily "school page" is still maintained by about 10 per cent. of the chief American dailies, the present tendency in newspaper treatment of education is away from such departmental methods: "educational" news should, it is considered, not be so labelled and should compete with other news for position. On the part of school and college authorities there is a marked disposition to welcome and co-operate with newspaper men. For example, one reporter was allowed to go through the schools of the city, sitting each day in a class-room among the pupils, to write a day-by-day first-hand account of schooling in all the grades.

Societies and Academies.

PARIS.

Academy of Sciences, July 30.—M. Guillaume Bigourdan in the chair.—Gabriel **Bertrand** and B. **Benzon**. A kind of physiological mutation observed in mice. During the study of the effects of the addition of a trace of zinc to the food of mice in the absence of vitamins, one mouse survived eleven weeks before showing any symptom of trouble, while all the other animals lived only from three to five weeks.—V. **Grignard** and M. **Dubien**: The condensing action of the mixed magnesium alcoholates, ROMgX. The alcoholates of the type $C_2H_5 . O . MgI$ produce energetic condensation of aldehydes and ketones, aldols being formed.—Jean **Chazy**. The field of gravitation of two fixed masses in the theory of relativity.—Th. **Varopoulos**: The number of exceptional values of multiform functions.—Ch. **Maurain, A. Toussaint,** and R. **Pris**: The measurement of air resistance on railway material. An account of the results of experiments carried out on a model train, one-twentieth real size.—Albert **Portevin** and François **Le Chatelier**: Obtaining, by heat treatment, light aluminium alloys of high tensile strength not containing magnesium. The effect of the temperature of tempering is given for an aluminium alloy (4·3 per cent. copper, 0·8 per cent. manganese, 0·38 per cent. silicon) and the results contrasted with alloys of the duralumin type containing magnesium.—André **Job** and Guy **Emschwiller**: The photochemical reduction of zinc sulphide. Phosphorescent zinc sulphide suspended in air-free water and submitted to ultraviolet radiation from a mercury lamp gives metallic zinc and free sulphur, some centigrams of zinc per hour being formed.—MM. **Wertenstein** and **Jedrzejewski**: The evaporation of carbon. The rate of evaporation (m) of carbon filament has been determined at temperatures between 2800° and 3500° C. absolute, and the results are in accord with the equation

$$\log m = 14.19 - \frac{47{,}000}{T} - 1.25 \log T.$$

From this, 5100° C. abs. is deduced as the boiling point of carbon.—P. **Lebeau**: A method of thermal fractionation of gases arising from the carbonisation of solid combustibles. The fuel is heated in a vacuum to temperatures increasing by steps of 100° C., and the gas pumped out at each stage and analysed. The results with seven fuels of different type are given in a diagram.—René **Reich**: New organometallic compounds: copper phenyl and silver phenyl. Copper phenyl has been isolated as the result of the reaction of dry cuprous iodide on an ethereal solution of phenylmagnesium bromide (in an atmosphere of nitrogen). The product is unstable, giving copper and diphenyl at 80° C. Copper ethyl proved too unstable to isolate, although there were indications of its formation. Silver phenyl was prepared by a similar reaction; under ether, at −18° C., it is completely decomposed in a few hours into silver and diphenyl.—L. **Bert**: Bromodiphenylmethane and the Grignard reaction. The main product of the reaction of magnesium on bromodiphenylmethane is tetraphenylethane.—M. **Pastureau** and H. **Bernard**: A new method of passing from mesityl oxide to tetramethylglycerol.—Alphonse **Mailhe**: The preparation of petrol starting with animal and vegetable oils. Rape oil, heated with zinc chloride, has been shown in an earlier communication to give rise to low boiling hydrocarbons. It is now shown that various other animal and vegetable oils behave similarly on heating anhydrous zinc chloride.—R. **Fosse**, Ph.

Hagène, and R. Dubois: Xanthyl compounds derived from amino acids.—Albert Michel-Lévy and Henri Termier: The Trapp rocks in the region of Raon-l'Etape (Vosges).—Etienne Patte: The isle of ashes, an Indo-Chinese volcano of recent appearance. This volcanic island was discovered in the process of formation by the Japanese ship *Wakasamaru* on March 2, 1923. The volcano was very active a fortnight later. By May 27, the area of the island had been reduced by about one-third, and the eruption had ceased.—F. Ehrmann and J. Savornin: Complement to the stratigraphic scale of the Kabylie des Babors, Algeria.—G. Pontier: The fossil elephants of England. The mutations of *Elephas antiquus* in the upper Pliocene and English Quarternary.—H. Colin and H. Belval: The soluble hydrocarbons of the wheat grain in the course of development.—A. Policard and G. Mangenot: The state of the oil in the reserve cell of the fatty seeds. The seed in germination.—E. Grynfeltt: The anatomical constitution and the signification of the pavilion of the uterine tube in woman.—Jules Amar: The phenomena of respiration. From a consideration of the total surface of the red blood corpuscles and the volume of oxygen consumed per minute, it is concluded that the hæmatic absorption is subordinate to the preliminary solution of the oxygen in the blood fluid. The true function of the red corpuscles is to increase, by their oxygen absorption, and to regularise, like a flywheel, the oxygen reserve of the higher animals.—R. Faillie and J. P. Langlois. The energy expenditure of the organism in walking down hill on an inclined plane.—R. Herpin: The swarming in full daylight of a *Pionosyllis lamelligera*.—Emile F. Terroine and H. Barthélémy. The composition of the organisms in the course of ovogenesis in the frog, *Rana fusca*. There is not a synthesis of fat at the expense of the tissues, but a transport to the ovary of fat previously accumulated in the organism. At the moment the eggs are delivered, the animal, without the ovaries, contains a very small proportion of fatty matter.—Ch. Dejean: The origin of the vitreous body and of the zonule.—O. Duboscq and P. Grassé: The small flagellæ of *Calotermes flavicollis*.—Etienne and Edmond Sergent and A. Catanei: Vaccination against paludism of birds obtained by the inoculation of a small number of living sporozoites.

MELBOURNE.

Royal Society of Victoria, June 7.—E. J. Hartung: The Mount Wilson solar observatory. A general account of the spectroheliograph and the establishment of the observatory on Mount Wilson was given. The solar tower telescopes, and the great reflectors for stellar and nebular work, were described and some of the lines of investigation which these instruments have rendered possible, were discussed. In conclusion reference was made to the projected Australian solar observatory on Mt. Stromlo, from which much may be expected.

June 14.—Mr. Wisewould, president, in the chair.—E. F. J. Love: Acceleration of gravity at the Melbourne Observatory. On taking Wright's determination into account, together with those utilised by the author in his previous paper, the value of g is increased, and the mean error diminished by 0·001 cm./sec.$^{-2}$. Reasons are given for regarding Wright's recent suggestion of variation in g with the time as unnecessary.—Sydney Pern: Different types of Australian boomerangs and their flight. The different types of war and return boomerangs, found amongst the various tribes were described, and also the methods of making the boomerangs, and how they were thrown. The author attributed the origin of the boomerang to the slow evolution of the throwing stick, which, when flattened and slightly twisted, was capable of greatly increased range. This stick took a slightly circular course, and by modifying it, a boomerang which would return was eventually developed. The different flights possible with the return boomerang were illustrated by wire models, and the method of throwing them to attain these different flights were explained. Four different ways of making the return boomerang were shown.

SYDNEY.

Linnean Society of New South Wales, April 18.—Mr. A. F. Basset Hull, president, in the chair.—W. F. Blakely: The Loranthaceæ of Australia, Pt iv. A continuation of the systematic descriptions, eleven species and six varieties being dealt with, of which six species and five varieties are described as new.—H. I. Jensen: Some notes on the Permo-Carboniferous and overlying systems in Central Queensland. A summary of the results of geological reconnaissance work in the country lying between the Charleville Railway line and the Longreach Railway line in Western Queensland. Notes are given on the geological sequence in the Carnarvons and on the Bowen formations in the type district.—Vera Irwin-Smith: Studies in life-histories of Australian Diptera Brachycera. (i.) Stratiomyiidæ. No. 4. The respiratory system in larva, pupa and imago of *Metoponia rubriceps* Macquart. A contribution to the subject of the post-embryonic development and comparative morphology of the respiratory system in Diptera and in insects in general.

May 30.—Mr. A. F. Basset Hull, president, in the chair.—H. J. Carter: Revision of the genera Ethon, Cisseis, and their allies.—T. Harvey Johnston and G. H. Hardy: A revision of the Australian Diptera belonging to the genus Sarcophaga. This group of flies is of medical and veterinary interest. Eight names are placed as synonyms for the first time, one new species is described, one is given a new name, and one, which evidently has been imported from North America, is added to the list, making twenty-three species now known from Australia.—A. A. Lawson: The life-history of *Microcachrys tetragona* (Hook.). Practically a complete account of the gametophyte structures of one of the rarest and most interesting of the Australian Podocarpineæ.—J. McLuckie: Studies in symbiosis. iv. The root-nodules of *Casuarina Cunninghamiana* and their physiological significance.

Official Publications Received.

U.S. Department of Agriculture: Bureau of Biological Survey. North American Fauna, No. 46: A Biological Survey of the Pribilof Islands. Pp. vi+255. (Washington: Government Printing Office.)

Publikationer fra Det Danske Meteorologiske Institut. Meddelelser. Nr. 5: Meteorological Problems. 1. Travelling Cyclones. By V. H. Ryd. Pp. viii+124. (Kjobenhavn: G. E. C. Gad.)

South Australia: Department of Mines. Mining Review for the Half-year ended December 31, 1922. No. 37. Pp. 95+1 plate. (Adelaide: R. E. E. Rogers.)

Madras Agricultural Department. Year Book 1922. Pp. ii+84+5 charts. (Madras: Superintendent Government Press.)

Madras Agricultural Department. Bulletin No. 85: A Summary of the Results of the Experiments on Paddy conducted at the Manganallur Agricultural Station. By N. S. K. Pillai. Pp. v+35+12 charts. (Madras: Superintendent Government Press.) 1 rupee 14 annas.

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Official Year 1921-22. Pp. ii+chart+29+5. (Madras: Superintendent Government Press.) 4 annas.

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Inventors and Patents.

THE relations which exist between an employer and his employee as regards patents for inventions are well known and, on the whole, are just and stand the test of time. On our part, we are always ready, and indeed anxious, to uphold the rights of inventors ; none the less so when the inventor happens also to be an employee. That there have been acts of injustice towards the employee is notorious, and that an inventor occasionally suffers at the hands of his employer is beyond dispute. It is well, therefore, to be reminded from time to time of the employee's views, if only to seek opportunity for the removal of hardship under which the employee-inventor may labour. To his grievances a short article by Mr. P. Freedman is devoted in the July-August number of the *Scientific Worker*, where, by a series of selected examples, there is advanced "a rough but true picture of the present trials of the needy inventor who is an employee of a private firm."

The details, however, of these examples, whereby the conclusions which have been drawn from them may be checked, are wholly absent. But without impugning in any way the accuracy of the examples, considerable experience suggests that the addition which inventors make to the stock of public knowledge is often neither so great in amount nor so important in extent as inventors would have us believe. Many a brilliant idea proves to be almost valueless to the community unless means for presenting it in practical form are devised by those whose everyday business is the immediate satisfaction of the public wants. Employers, as is said, must live, and it is to their interest to adopt the latest and most efficient devices irrespective of the quarters in which they arise. The subtle and elusive quality of inventiveness is such as to require all the efforts of employers to stimulate its exhibition by those in their employ. Harsh and inequitable treatment of employees conduces to the satisfaction of neither party. In short, mutuality in aim with due regard to the dictates of justice are, in the long run, found to pay.

In the same article the suggestion is put forward for a patents committee to be set up to report upon novel ideas, the members of the committee being thoroughly able technical men and men of high reputation. The good opinion of this body would enable the inventor "to obtain financial backing for his idea and free him from rank robbery." It would also help, it is said, in bringing the inventor into touch with those who might assist him in furthering his aims. The author of the article deliberately abstains from elaborating the scheme in detail, but in this matter urges energetic action

as the policy of the National Union of Scientific Workers.

The idea of a patents committee of this character, it may be remarked, is a favourite one with reformers, but however much there is to be said in its favour, its formation, functions, and operations would be such as to render the idea all but impossible in practice. A very near approach to the constitution and working of such a committee was to be witnessed during the War. Many consultative bodies, in the exceptional circumstances of the time, were established by the Ministry of Munitions for estimating the value of inventions. As a result, a vast accumulation of information upon the practical working of those consultative bodies was obtained; information which, if made available to the public, would indicate how little the expectation of reformers in this direction could be realised. Sound contribution to the discussion of the relation between employer and employed as regards inventions and their mutuality of interest is ever welcome, and in the proper quarters should always receive careful attention. It is open to question, however, whether the claims of the employee will be materially enhanced by the advocacy which appears in the *Scientific Worker*, where some basic misconception occurs in respect of the employee's legal position, and where the implication lies that all employers are to be judged by reference to the action of those who abuse their position.

In a second article devoted to patents in the same issue of the *Scientific Worker* Dr. N. R. Campbell urges the entire abolition of the patent system without any definite substitute. He considers that the system gives industrialists a wholly false view of the place of science in industry and, in consequence, diminishes the number of scientific workers whom they employ. "So long," says Dr. Campbell, "as we associate scientific work with patents, the delusion that is responsible for the backward state of scientific industry in this country will continue," and, if patents were abolished, manufacturers would have to rely upon the excellence of their products and the efficiency of their processes and not on the establishment of monopolies. There must be dismissed once for all, Dr. Campbell continues, the wild idea that, by some modification of patent law or machinery, there can be wrested from the greedy capitalist some enormous profit that he makes by exploitation of the inventor.

Dr. Campbell refers also to the necessity, in the case of a really important invention, of spending many thousands of pounds upon defending a patent in the courts. This necessity is and has been a crying evil which seems to be almost inseparable from the existing patent law. It is indeed remarkable that the talent of the legal expert united with the genius of the manufacturer have not yet succeeded in evolving a scheme whereby, at a relatively small cost, the scope of an invention may be accurately defined and the validity of its protecting patent readily determined. The difficulties in the production of such a scheme, which without losing sight of the interests of the public shall yet reserve to the inventor all the rights to which he is entitled, are undoubtedly great; but surely some means are discoverable whereby the present outlay for obtaining confirmation of an important patent and the settlement of the allegation of infringement could be much reduced. The National Union of Scientific Workers would indeed be doing true yeoman's service if, in all its bearings, the Union would consider this matter and assist in bringing about a much-needed reform.

The Social Influence of the Internal Combustion Engine.

The Internal Combustion Engine. By Harry R. Ricardo. Vol. 2: *High-speed Engines.* Pp. vii + 373. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1923.) 30*s.* net.

IT does not seem long ago, though actually fourteen years have passed, since we overheard a well-known man of letters gently curb the impulsive pen of a younger writer who wished to record an impression that the increasing use of the internal combustion engine must prove a vital factor in our coming civilisation. Events have moved so rapidly that it now seems surprising that this impression could have appeared to be an overstatement. But fourteen years ago the man-in-the-street was quite unaware of what sort of thing an "internal combustion engine" might be, if indeed such a thing existed. Moreover, until that time no engineering writer had even dared to put so unfamiliar a title on the cover of his book. Gas engines, oil engines, and petrol engines were of course known, but it was scarcely suspected that apparatus of that sort was likely to have any primary effect on world history.

Who would have then divined that the introduction by Daimler, fourteen years still earlier, of the high-speed petrol engine was of such potentiality that it would become a debatable point whether our "sure shield," the British Navy, should be allowed to have its Singapore base strengthened, in advance of the provision of an adequate home defence force of those aircraft the very existence of which is one outcome of the pioneer work of Daimler? This is, it is true, merely a military parallel, but equally striking ones could be drawn from civilian activities. The development of internal-combustion-engine road transport is one of the

chief characteristics of the age we live in. Even in England it is sufficiently striking, but in the United States one person in every ten, man, woman, and child, has an automobile; an average of one to every alternate household. Even so the continued output of the Ford factory is measured in thousands of cars per day. America may be a land of wide spaces, but if this rate should continue it is not difficult to foresee a further field for the activities of "control" societies, this time aiming at control of the Ford "birth rate."

The growth of road transport was not due to the stimulus of the War: it was in full steady growth before 1914. But in the case of aviation, the future of the aero-engine as a prime mover is, and must be, vitally affected by the stimulus which grew from the War and still continues. During the War itself the best scientific and engineering talent was encouraged by every possible facility, and by lavish outpourings of money, to produce yet newer and newer developments of the internal combustion engine—whether for aviation, tanks, seagoing craft, or road transport; but chiefly for aviation. Aviation offered then a prospect of a way out from what seemed an endless deadlock; people had begun to fear that in the great struggle, there had unconsciously been invented a new, and very unpleasant, way of life. Since then a relatively impoverished world has sought to find less costly means of defence than the old; and the public, led doubtless by the results of certain American experiments, has begun to look towards the relatively cheap defence by aircraft as affording a loophole for escape from financial burdens which might threaten to become overwhelming. As a mere business proposition, therefore, it "pays" to encourage aviation, and the surest path of progress in this sense lies in the development of improved aero-engines which shall be of unprecedented power, of extreme lightness, and yet be able to operate with equal facility at any altitude and at any temperature.

One of the pioneers in this necessary development of the internal combustion engine is Mr. Ricardo. We reviewed some little time back the first volume of his book (NATURE, January 13, p. 43). That volume dealt mainly with the older slow-speed engine. The second volume is concerned with the high-speed engine and with its utilisation for certain specialised purposes. It is a fine record of scientific research work; carried out in no small measure by Mr. Ricardo himself, or by those with whom he has been associated, directly or indirectly, through the medium of the Aeronautical Research Committee.

We are well acquainted with most of the books on this subject which have appeared during say the last twenty years, and it is striking to reflect on the change in the point of view shown by the writers at the beginning of that period and at the end. If Mr. Ricardo be taken as typical of the modern writers, and to do so is to pay them compliment, it will be seen from even a cursory survey of the present volume that nothing, however traditional in the art, is taken for granted. Each problem is stated in scientific language, and critically and dispassionately examined: very often the results are unexpected, but whether strange or not, this critical review of them has the immense merit that a chain of possible causation is constructed to which new links can be added, by those who have scientific imagination and insight, leading to new lines of development. Each piece of analysis in fact is made to carry within it the germ of the next step forward.

The mere bulk and weight of Mr. Ricardo's two volumes is forbidding, and might with advantage have been lessened. That, however, is probably more a matter for the publishers than the author. The author has done his part of the work well, though the book would certainly have gained by the freer use of the blue pencil. We have found very few mistakes, though the puzzling letter-press associated with figure 33 on p. 121 does not seem to us to make the carburation procedure represented intelligible to the average reader.

Mr. Ricardo is evidently not satisfied with the present position as to fuel supplies. As is well known, much of his own research work has been devoted to fuel questions —his investigations for the Asiatic Petroleum Company he has fortunately been in a position to make public: much to the credit of that firm. We quote from the present volume: "The mobile internal combustion engine is now no longer a luxury; it has become one of the prime necessities of peaceful civilisation and the prime necessity in time of war; therefore, the assurance of its fuel supply should be considered a matter of national importance. It is perfectly well known that alcohol is an excellent fuel, and there is little doubt that sufficient supplies could be produced within the tropical regions of the British Empire, yet little or nothing is being done to encourage its development." It must be remembered, however, that although plants well suited for the production of alcohol are easily grown in, say, tropical British Africa, it is likely to be a costly matter with present facilities to collect and deal with the material on the spot; hence it is reasonable that a very strong case should be put up by the engine users before steps are taken to embark on large schemes for power alcohol production.

Lest it should seem that the high-speed engine is being considered too exclusively and the older engine ignored, Mr. Ricardo puts his view on record: "That the internal combustion engine has found its ultimate sphere in the light mobile high-speed type is now evidenced by the fact that, whereas in the years

immediately before the War the annual output in horse power of both the light and heavy type in this country was about equal, to-day the aggregate annual power output of the light high-speed type is at least ten times that of all other types, and in numbers probably nearer twenty times."

We welcome this book, and we congratulate the author upon its production and upon his distinguished share in the campaign towards yet further developments. Those who take their stand with the outposts in this campaign and endeavour thence to discern what yet lies in the lap of time will share with Mr. Ricardo his enthusiasm for one of the most stimulating of adventures in the world of applied science.

H. E. W.

The Secret of Life.

The Mechanism of Life in Relation to Modern Physical Theory. By Prof. James Johnstone. Pp. xii + 248. (London: Edward Arnold and Co., 1921.) 15*s*. net.

THE professor of oceanography in the University of Liverpool is well known as an eminent biologist with strong philosophical leanings and an unusual knowledge of physico-chemical science. So the title of this book and the name of its author lead one to expect something of more than ordinary interest. It may be said at once that this expectation is fully justified, for Prof. Johnstone's book is uncommonly stimulating and represents a real and determined effort towards scientific synthesis.

In the first eight chapters, the subjects of which are the nature of animal life, the sensori-motor system, the principles of energy, the sources of energy, on vital production, brain and nerve, the special nervous mechanisms, and the analysis of behaviour, the author gives the reader an excellent and readable outline, well illustrated with diagrams, of some of the fundamental aspects of physiology and the theory of energy (including the second law of thermodynamics). It is fairly obvious that these chapters are written for the purpose of preparing the uninstructed reader to understand what is to follow, for it is in the last three chapters, on the mechanistic conception of life, the meaning of perception, and the nature of life, that we come to the kernel of the matter.

In the first of these chapters the author describes the mechanical system of Descartes. Having disposed of Descartes, he then proceeds to demolish Jacques Loeb, in other words, he finds the modern physico-chemical "mechanisms of life" equally unsatisfying, equally mechanical. But the last paragraph of this chapter, like the concluding sentence of one of those serial instalments of "blood and passion" that appear in certain magazines, shrewdly whets our appetite: "Anyhow, our mechanism of the organism has come again to a crisis. First of all it was a mechanical explanation of life, and that being insufficient, biology resorted to a physico-chemical explanation, which was also insufficient, since physics and chemistry are again becoming mechanical. Looking about for the new conception that biology has now again to borrow from physics, we have little difficulty in finding it, and it would appear as if it were really something new. The concept is given to us in the physical notion of statistical mechanics and to this we shall return presently."

This sounds exciting, though it is not quite evident at first sight why statistical mechanics should be any better than mechanics. However, the secret comes out in the last chapter, which treats of "The Nature of Life." Here the author deals in a very interesting way with the laws of thermodynamics, his discussion being based on the statistical methods of Boltzmann and Smoluchowsky. It is pointed out that the universe "becomes a cyclic order, such that the most probable phases are those in which entropy tends towards its maximum value, and the least probable ones are those in which the entropy tends towards its minimum value. As such it is a permanent universe, self sufficient, without beginning and without end."

Proceeding from this basis, the author arrives at the following result. In inorganic processes and tendencies available energy runs down and entropy increases; whereas in "vital" processes and tendencies available energy accumulates and entropy decreases. Summing up, he states that "In living processes the increase of entropy is retarded. This is our 'vital concept'." His exact meaning will be rendered clearer by the following quotation. Discussing the photosynthetic action of the green leaf, he says: "Starch accumulates in the green leaf exposed to sunlight, but the *whole* system is the green leaf + the CO_2 and H_2O + the 'degrading' sunlight. In the system thus defined entropy increases very slowly. The system is one in which there are *coupled* energy transformations. (1) the degrading sunlight; and (2) the photosynthetic process. If there were no coupling, the solar energy would degrade, with a maximum entropy increase; if there is a coupling the entropy increase becomes minimal. The coupling is always the mark of life activity."

Suppose we illuminate some oxygen at room temperature with the right sort of ultraviolet light. Some ozone is formed. In this *inorganic* system we have two coupled energy transformations, (1) Oxygen ⟶ Ozone, with increase of free energy and diminution of entropy; (2) "degrading" ultraviolet light, with diminution of free energy and increase of entropy.

Suppose again that we shake a solution of oxygen in water with zinc filings. Some hydrogen peroxide and some zinc hydroxide are formed. Here again we have an inorganic system and two coupled energy transformations, (1) Oxygen + Water $\longrightarrow$ Hydrogen Peroxide, with increase of free energy and diminution of entropy; (2) Zinc + Oxygen + Water $\longrightarrow$ Zinc Hydroxide with decrease of free energy and increase of entropy.

Hundreds of such examples might be given. For example, by a suitable coupling of voltaic cells we can realise the pair of coupled transformations, (1) $H_2 + I_2 \longrightarrow 2HI$ *aq.*, with increase of entropy; (2) $2HCl$ *aq.* $\longrightarrow H_2 + Cl_2$, with decrease of entropy. Thus, a coupled transformation involving, when taken by itself, a decrease of entropy, is no prerogative of the living cell or organism. The latter is not a bit from an "improbable" part of the universe, which is retarding or reversing the operation of the second law of thermodynamics in our particular part of the universe. A living cell or organism does not, as it were, act spontaneously. If we could photograph Mr. Home in the act of "spontaneous levitation," we could wager quite safely on the existence of a "coupled degradation," even if we could not see it. The continued activity and existence of a living organism depend on its utilisation of an environment which is not in perfect thermodynamic equilibrium. The totality of the actions involves a decrease of free energy (increase of entropy), while a part will in general involve a "storing of availability," *i.e.* an increase of free energy and a decrease of entropy. But this is a general characteristic of most complex physico-chemical actions and reactions, including also the physico-chemical actions and reactions of the living organism and its environment. These facts are, of course, well known. The late Prof. Benjamin Moore often pointed out that the living cell acted as an "energy transformer." What he really meant was that it acted as a transformer of "energy potential," running some energy up to a higher "potential," and some down to a lower "potential," like an electrical transformer. If such coupled transformations never occurred in what we call the inanimate world, then we might find here a real prerogative and characteristic of vital activity. But the existence of such coupled "up-and-down" transformations in the inorganic world is the commonest of occurrences. The inorganic world in its various transactions does not, in fact, only "go down hill." The progress of the rake is zigzag, and not wholly a piece of undiluted villainy.

In trying to gain an understanding of the totality of the actions of a living organism, it appears to the reviewer that we may have to seek it in the intimate actions or "behaviour" of particular individual entities, rather than in the average statistical behaviour of "crowds." A piece of radioactive material decays according to the mathematical laws of continuous change, but behind this apparent continuity there lies a series of discontinuous changes or "mutations." The apparently continuous activity manifested in an ordinary chemical reaction, which can also be represented by the mathematics of continuity, is due in reality to a hidden series of "critical" states and "critical" transformations. Everywhere the "evolutionary changes" of individuals appear to be of a discontinuous, critical, or mutational type. Behind or below the determinism of our statistical laws of physico-chemical change there lies a deeper determinism based on the transformations of particular individuals at particular moments. Modern physico-chemical science has already obtained a large measure of success in analysing this apparent "spontaneity" and in discovering the intimate laws of action of individuals. The City Actuary is being replaced by the Harley Street physician. Meanwhile, the philosopher with his *élan* of impatience (and ignorance) hurls defiance at the harmless corpse of the older determinism.

Prof. Johnstone's book contains much more, however, than his attempt to find a characteristic or criterion of vital activity in statistical mechanics. It deals with such subjects as perception, behaviour, mind, memory, freewill, habit, etc., and attacks the doctrine of determinism as applied to the deliberative actions of animals. Thus the author says: "In most animals there is some indetermination and spontaneity of behaviour, and the more highly organised is the central nervous system, the greater seems to be the degree of indetermination that is exhibited." In much of this discussion he reveals himself as a follower of Bergson.

Finally, Prof. Johnstone, the philosopher (as distinct from the psychologist and biologist) allows himself the luxury of what he calls a "metaphysical discussion," which, however, he relegates to an appendix. We need not follow him into those "faery lands forlorn." Philosophers (*i.e.* the professional sort) live by taking in each other's washing, and it is no part of good manners to interfere with these detergent ceremonies.

The general impression which one gains from this book is that the author is dissatisfied with the present-day physico-chemical description of biological sequences. But it does not appear that he has anything better to offer. We have seen that his thermodynamical (or statistical mechanical) discussion provides nothing new. He brings in the modern physical theory of relativity and seems to find some comfort in the reflection that

the electrons, atoms and molecules, when going about their lawful occasions are, after all, only successive space-time coincidences. But so, also, are the biological sequences !

Nevertheless, Prof. Johnstone's book is the work of an honest, mature and determined thinker, who possesses a good knowledge of physics, chemistry, and biology. As such it is worthy of very serious consideration and thought, and constitutes a most interesting contribution to scientific literature.

F. G. DONNAN.

The Geological Description of Britain.

(1) *Memoirs of the Geological Survey: England and Wales.* Explanation of Sheet 96: *The Geology of Liverpool, with Wirral and part of the Flintshire Coalfield.* By C. B. Wedd, B. Smith, W. C. Simmons, and D. A. Wray. Pp. vi+183. 4s. net.

(2) *Memoirs of the Geological Survey: England and Wales.* Explanation of Sheet 169: *The Geology of the Country around Coventry, including an Account of the Carboniferous Rocks of the Warwickshire Coalfield.* By T. Eastwood, Dr. W. Gibson, T. C. Cantrill, and T. H. Whitehead. With contributions by Dr. H. H. Thomas and the late C. H. Cunnington. Pp. viii+149+8 Plates. 5s. net. Also Sheet 169, 1 inch to 1 mile, colour-printed, Drift edition, 2s.

(3) *Memoirs of the Geological Survey: Scotland. The Geology of Corrour and the Moor of Rannoch* (Explanation of Sheet 54). By L. W. Hinxman, R. G. Carruthers, and M. Macgregor. With contributions by the late Dr. C. T. Clough, and Petrological Notes by Dr. H. H. Thomas and H. H. Read. Pp. iv+96. 4s. net. Also Sheet 54, 1 inch to 1 mile, colour-printed, Drift edition, 3s.

(Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1923.)

UNDER the direction of Dr. J. S. Flett, the Geological Survey of Great Britain, with its happily increased emoluments and staff, remains one of the most progressive scientific institutions in the British Isles. The first two memoirs here noticed are based on the revision of mapping done in earlier days, and they form an effective answer to those who hold that geological observations once recorded are incapable of improvement in the light of later knowledge.

(1) The account of the Liverpool district is appropriately published in time for the visit of the British Association. Details derived from mining developments have been utilised, and twenty-four shaft-sections in the Flintshire coalfield are represented in a plate. The account of the recent improvements in water-supplies (pp. 127-147) records the great success of the Vyrnwy reservoir, which was completed in 1892, only 7·2 per cent. of the water used by Liverpool being now drawn from wells in the Bunter beds that underlie the city. The case of Holywell in Flintshire down to the days of the War, when the water was carted to the upper part of the town from the holy well of St. Winifred, and then dispensed in buckets, is quaintly described. This supply was seriously reduced in 1917, by being tapped by mining operations, and at present a reservoir is being utilised to receive water pumped from neighbouring shafts.

The glacial deposits of the district now receive concise description, based upon studies by Mellard Reade, G. H. Morton, and others, who have made Liverpool famous as a centre of geological observation. Important modifications have, however, been made in older views as to the mode of deposition of the drifts, and it is well to have the evidence of the striation of the rock-floor by ice from the Irish Sea conclusively put forward (p. 96). The glacial striæ occur mainly near the coast; they are directed to the south-east; and 58 per cent. of the boulders from a clay-pit in Stanley Road (p. 95), examined by Morton and Goodchild, showed striations on their surfaces. The list of erratics includes rocks from the county of Antrim, Ayrshire, Ailsa Craig, and the Isle of Man. The evidence for the existence of a great Irish Sea glacier is here complete.

(2) The memoir on the "Country around Coventry" is in reality a description of the area of the accompanying Sheet 169 of the colour-printed one-inch map, and covers the very interesting district north and north-east of the city. The whole of the Warwickshire coalfield, which extends into Sheet 155, has, however, been included in the memoir. Educationally, the map is a fine one from the contrast in structure of its eastern and western areas, the Cambrian shales and quartzite coming in west of the great fault, and underlying the Middle Coal-measures, while the drift-covered Triassic country to the east includes the remarkable inlier of ancient quartz-diorite, formerly styled granite, that is quarried at Lane's Hill.

It is suggested on p. 20 that this and the similar rock of Mount Sorrel, which formed part of the land-surface in Triassic times, may be of Devonian age, like the granites of the Lake District and of southern Scotland. We note among the geographical features the growth of Coventry in consequence of the mining activity north of it (p. 1), and on the map the grand old line of Watling Street, with the main route of the London, Midland, and Scottish Railway, keeping similarly to the Triassic lands.

(3) The third memoir dealt with in this notice leads us to a very different country. The Moor of Rannoch

has now been traversed by the railway to Fort William; but its essential wildness remains, and has become known to thousands who otherwise could have realised little of the grimness of the central highlands. We are here on the watershed between the North Sea and the western inlets, and its rugged characters seem typified in the trench-like hollow in which Loch Ericht lies (p. 9). The contoured geological map, with its audacious mass of scarlet where the early Devonian granite forms the moorland, should be studied side by side with the hill-shaded sheet of 1876, on which Mr. R. McFadden gave us what is surely one of the finest examples of hachuring in the world.

The question of recumbent folds among the metamorphosed stratified series has been raised by Mr. E. B. Bailey, and the views of the official geologists in this difficult region show healthy differences that will stimulate yet further work. By any one who has emerged on the moorland from the deep cleft of Glencoe, the courage of those who have investigated the district yard by yard must be gratefully acknowledged and admired. The most striking feature of the description of the glacial deposits is the evidence that boulders of the Rannoch granite have been abundantly lifted by the land-ice to heights of 1000 feet above the level of the moorland mass. G. A. J. C.

Medical Science in the War.

History of the Great War: Based on Official Documents. Medical Services: Diseases of the War. Vol. 2: *Including the Medical Aspects of Aviation and Gas Warfare, and Gas Poisoning in Tanks and Mines.* Edited by Maj.-Gen. Sir W. G. Macpherson, Maj.-Gen. Sir W. B. Herringham, Col. T. R. Elliott, and Lt.-Col. A. Balfour. Pp. viii + 621 + 7 plates + 6 maps. (London: H.M. Stationery Office, 1923.) 25*s*. net.

AS the details of the War fade away into the past, our perspective of the ordeal emerges more and more clearly, and when viewed from a distance of five or more years, the magnitude of our effort begins to make itself apparent. Time, if it has not yet healed our wounds, has at least enabled a considered diagnosis and history to be made. How wonderful that history was, how resourceful our resistance, how well-earned our victory, can be gathered by reading this truly fascinating account of the work of the Medical Services during the War. Never before in war has the air played so big a part; its physical properties have loomed large in problems of aviation, while its importance in respiration has made physiology one of the most indispensable of sciences in connexion with aviation, gas warfare, and mining operations.

Application of the results of scientific research led to the solution of most of our difficulties. By careful tests men could be selected who were physiologically suitable for flying, while those unfit could be eliminated; "flying strain" could be detected and treated; by the use of liquid oxygen aviators could reach heights otherwise unattainable, and still retain their efficiency. Many lives were saved, and considerable advantage gained in consequence.

After that portentous experiment of April 22, 1915, when the aspect of warfare was changed by the use of asphyxiating gas by the Germans, stupendous efforts were made to devise protection against this form of attack. For a while, gas offensive and anti-gas protection strove, on either side of that awful strip of neutral land, each to outdo the other; the ultimate victory was with the defence.

That the British box respirator was easily the best in the field cannot be denied by any one who knows all the facts, for it was satisfactory both from the chemical and physiological point of view, and hence this form of respirator was greatly in demand not only for the use of our own troops, but also for those of several of our allies. Its evolution from less perfect predecessors is fully explained in the tenth chapter of the book. Chapter ix. contains a full account of several gas attacks made upon our troops; in one case at least the reviewer can testify to the complete accuracy of this official account, and has no doubt that all the other accounts are equally accurate, since they were written up in the field by exceptionally able Army chemical advisers, on the basis of verified reports by the units concerned.

Gas warfare reached a crescendo in July 1917 when mustard gas was first employed, and the number of casualties suddenly jumped up, and even with the most stringent precautions remained high until the end of the War. This was due, not to inefficiency of the respirator, but to difficulties of detection of the gas, and to damage done to the general body surface by the substance. In spite of all our precautions the total reported gas casualties were 180,983, not counting some who died on the spot, or were taken prisoner; something more than 6000 of these died, while about 19,000 had been classed for pensions during the year 1919–1920. This forms about 2 per cent. of the total post-War disabilities, which is only a small number; very few of these men have since died from indisputable effects of gassing. The medical treatment of gas-poisoning may therefore be said to be fairly satisfactory, and is fully discussed, together with the pathology of gas-poisoning, in the official account.

Much has been written elsewhere about gas warfare; it has been described as a cheap, effective, and humane means of attack, and also as the most costly, most

ineffective, and most brutal weapon yet devised. That it has come to stay is certain; that it cannot be ignored is incontestable; that it may even be the means of ultimately extinguishing the civilisation which has engendered it seems not impossible. No one could read this considered account without being impressed by its fundamental significance.

There is one gas against which the respirators are not effective; this is carbon monoxide. It was not, and could not easily be used as a means of attack, but was encountered in ill-ventilated tanks and in mines after a blow had occurred. This danger was met, as similar danger is met in coal mines, by the use of some form of oxygen respirator. Mine rescue work, and the treatment of carbon monoxide poisoning, form the concluding chapters of this valuable and interesting document.

The Foundations of Future Psychology.

The Nature of "Intelligence" and the Principles of Cognition. By Prof. C. Spearman. Pp. viii+358. (London: Macmillan and Co., Ltd., 1923.) 15*s.* net.

"IN these principles, then, we must venture to hope that the so long missing genuinely scientific foundation for psychology has at last been supplied, so that it can henceforward take its due place along with the other solidly founded sciences, even physics itself. In particular, these principles (together with commentaries upon them) appear to furnish both the proper framework for all general text-books and also the guiding inspiration for all experimental labours."

This is the author's very confident conclusion. The source of cognition, he holds, is experience. This he defines as "that which is immediately lived, undergone, enjoyed, or the like"—a definition which would appear to include digestion and the hardening of one's arteries.

The first intelligent operation is the apprehension of experience. This is said to include sentience, affection, cognition, conation, and the *ego*. The inclusion of the *ego* is firm but apologetic, "pending some much more plausible alternative explanation being proffered." It is hinted (but not argued) that the fundamental connectedness of these items is also apprehended at this primary level.

The second principle—the "eduction of relations"—states that "the presenting of any two or more characters tends to evoke immediately a knowing of relation between them." The proof of this "tendency towards evocation" appears to be that these relations may be discovered. These relations include all the categories—time, space, causality, and the rest. All are neatly ticked off.

The third principle—the eduction of correlates—is that "the presenting of any character together with a relation tends to evoke immediately a knowing of the correlative character." This principle is very thoroughly elaborated and illustrated.

These principles and their manifestations are called "noegenetic" because they are "noetic" (self-evident) and generate further knowing. They are "the principles of intelligence" and fundamental for cognition.

The book, we are told, is "solely psychological and by predilection practical." The author, in consequence, believes himself justified in adopting the methods of a drumhead court-martial on the frequent occasions when he tackles metaphysical points. Since the essence of his argument, however, is noetic self-evidence, it is difficult to understand what he means by unadulterated psychology. Certainly he makes a most resolute attempt to illustrate and corroborate his results from laboratory evidence; and this is the most valuable, as it is also the most distinctive, feature of his discussion. He is far too clear-headed, however, to mistake corroborative for fundamental evidence.

Take, for example, one of his favourite topics—the initial status of sense-experience. Neither his choice of this topic nor the greater part of his treatment appears to be predominantly psychological. He begins with the argument commonly known as physiological scepticism, and ignores the vicious circle it contains. Satisfied with this, he appears to rely on self-evidence until quite late in the work, when he brings corroborative experiments to bear upon his implied assumptions concerning this "tremendous problem of objectivity." It is true that he assigns to these experiments much greater value than is due: but his fallacy is logical, not experimental. To pass other points, the brunt of his discussion here concerns subjectivity in the sense of "actually constituting your state of consciousness as when you say 'My consciousness was that sensation.'" Since many philosophers hold that no one can ever truthfully say any such thing, it is plain that this "experimental" question is a flagrant *petitio principii*.

The same remarks seem apposite when the author deals expressly with "transcendence." It is clear to him that somehow we come to know what is not a state of ourselves, and he alleges that we do this by educing correlates. We apprehend the *ego*, grasp the relation of otherness, and educe a not-self (p. 107). This looks simple. Self and otherness, together, will give you, of course, "other selves," or "other than any self," or "anything other than yourself." You can therefore "educe" or "draw out from the very nature of the item (yourself) presented" your parents or, if you will, the rest of the universe. In short, anything can be done by these methods, and it is not at all clear why the author did not choose to "educe" "non-experience"

from "experience" or "infinite objectivity" from "finite subjectivity."

These principles are called "qualitative," but there are also five "quantitative" ones, and three further "anoegenetic" principles of reproduction, disparition, and variation of clearness. I have space only for a few remarks on these heads.

The first three of the five quantitative principles run as follows: (1) Every mind tends to keep its total simultaneous cognitive output constant in quantity however varying in quality; (2) the occurrence of any cognitive event produces a tendency for it to occur afterwards; (3) the occurrence of any cognitive event produces a tendency opposed to its occurring afterwards.

Of these (1) looks as if it meant that every sleepy mind tended to have the same cognitive output as it has when alert. This, however, is not what is meant. Our author seems to mean instead (p. 131) that the occurrence of any one noegenetic process tends to diminish the others. The second noegenetic process, however, presupposes and includes the first.

(2) and (3) are flatly contradictory, so that it is difficult to know what to do with them. They are called respectively Retentivity and Fatigue. It may be worth remarking, then, that Fatigue, in ordinary language, does not contradict (2). When you are tired you are likely to stop, but *afterwards* you may begin again.

I do not mean these criticisms to be verbal, but I should be glad if they were. For the author's courage and resource I have nothing but admiration, and his vigour is always refreshing. JOHN LAIRD.

Our Bookshelf.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. 1: *Tungsten and Manganese Ores.* Third edition. By Henry Dewey and H. G. Dines; with Contributions by C. N. Bromehead, T. Eastwood, G. V. Wilson, and R. W. Pocock. Pp. iv+83+3 plates. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1923.) 2*s.* net.

THE latest edition of the report on the British ores of tungsten and manganese merely brings up-to-date the information contained in the previous editions, but it cannot be said that it has brought out any new facts of importance. Perhaps it only serves to emphasise the industrial unimportance of the British sources of supply. Temporarily the War directed attention to the domestic sources and caused these to be actively worked, but under post-War conditions, the home deposits have again been found to be unable to compete with the richer deposits that exist abroad. This is well exemplified by the ores of tungsten, the British output of which touched nearly 400 tons per annum during the War, while the output to-day is probably less than a quarter of this quantity; in the same way the price, which during the War reached 55*s.* per unit, is to-day only about 12*s.* Furthermore, the total output from Great Britain is only about 2½ per cent. of the world's production.

In the case of manganese ores the figures show the same tendency, though not to so marked an extent; this is due in part to the fact that the great bulk of the British ores of manganese are of low grade compared to the imported ores. The chief centre of our home supplies is in North-West Wales, in Carnarvonshire and Merionethshire, both of which districts are well described in the present report. These ores appear to average less than 30 per cent. of metallic manganese, while imported ores contain at least 50 per cent. Even so, however, the tonnage of domestic ores is barely 1 per cent. of the world's production, and only about 2 per cent. of our imports. Economically, therefore, the British production of both these ores is negligible, and a careful study of the report before us affords no ground for hope that it will ever become a factor to be reckoned with in the world's markets for either mineral.

Cements, Limes and Plasters: their Materials, Manufacture and Properties. By E. C. Eckel. Second edition, revised and partly rewritten. Pp. xxxi+655. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 32*s.* 6*d.* net.

ECKEL'S treatise on cements, although dealing almost exclusively with American practice, is one of the most thorough works on this subject, and the new and revised edition will be accepted as a standard authority. The scanty references to English practice are not always accurate, and the casual reader might suppose that the industry in Great Britain was insignificant, but the information in regard to the United States and Canada is very full. A more detailed account of the fixed mechanical kilns which are now assuming so much importance would have been welcome, as they are now becoming serious rivals of the rotary kiln. It has been found possible to include a short account of the high-alumina cements recently introduced, although there is no systematic consideration of their properties. The section on slag cements is misleading. Only the older pozzolanic cements, consisting of mere mixtures of granulated blast-furnace slag and lime, are considered, and the much more valuable "Iron-Portland" or "Blast-Furnace Portland" cements, made by mixing a suitable granulated slag with clinker and grinding together, are not even mentioned. The chemistry and physics of cement do not receive attention, the treatment being purely empirical, but within its limits the book gives an excellent survey of an important American industry.

The Causes and Prevention of Corrosion. By A. A. Pollitt. Pp. 230. (London: Ernest Benn, Ltd., 1923.) 25*s.* net.

THE literature of corrosion is extensive, but far from satisfactory in its scientific aspects. There is a large collection of facts, but a singular lack of co-ordinating principles. Each experimenter has his own hypothesis, which fits a small group of observations, but usually breaks down when applied to other, nearly related facts. The writer of the present work has prepared a useful survey of the subject, although confining

himself almost exclusively to work published in English, and without any evidence of first-hand observation. Concrete examples, so important in such a subject as this, are lacking, and the reader is thus little able to judge of the relative merits of the rival hypotheses, which are, however, fairly and accurately described. The corrosion of steel boilers and of brass condenser tubes is treated more fully, the section on the latter subject being reprinted from a pamphlet issued by the Corrosion Committee of the Institute of Metals. The most valuable part of the book deals with the prevention or diminution of corrosion, especially of boilers and condensers. Here the author is evidently at home, and the chapters on the softening and de-aeration of water, and on the protection of boilers by electrolytic methods, are fully illustrated and contain much detail. This portion of the book might well have been issued alone, a procedure which would have lessened its rather high cost. The printing is good, and the illustrations of plant are very clear.

The Bakitara or Banyoro: the First Part of the Report of the Mackie Ethnological Expedition to Central Africa. By the Rev. Canon J. Roscoe. Pp. xvi + 370 + 42 plates. (Cambridge: At the University Press, 1923.) 25*s*. net.

ANTHROPOLOGICAL science owes a debt of gratitude to all who were concerned in the initiation and organisation of the Mackie Ethnological Expedition to Central Africa; but most of all to Mr. Roscoe, by whom the actual work of investigation was carried out. This first instalment of his report is an invaluable contribution to our knowledge, and will prove an almost inexhaustible mine of information for the student of primitive custom and belief. The dominant people of the country of Kitara are the Bahuma, Negro-Hamites, possibly of Galla strain, though this is uncertain. Coming from the north-east, they invaded the country in the lake region immediately west of Uganda, part of which they now occupy, and subdued the Bahera, the agricultural negro aborigines. Among much which is striking in their culture, the most remarkable feature is the manner in which their whole social and religious organisation centres around their herds. The entire routine of the kingly office is ordered solely to promote by sympathetic influence the well-being of the cattle. The elaborate milk ritual, which Mr. Roscoe has studied carefully in minute detail, inevitably invites comparison with the dairy cult of the Todas of Southern India.

L'Homme fossile de La Quina. Par Dr. H. Martin. (Archives de Morphologie générale et expérimentale. Fasc. 15: Anatomie.) Pp. 260. (Paris: Gaston Doin, 1923.) 25 francs.

IN this volume Dr. Martin describes the results of the investigations which he has carried out on the Mousterian site of La Quina (Charente) since 1905. His discoveries included a large number of mammalian remains and of typical implements as well as objects of bone, which at the time of discovery constituted the first evidence of the use of bone in the Mousterian age. Much of this material has formed the subject of communications to French scientific societies, and the general conclusions are well known; but anthropologists will welcome this careful and detailed study of the evidence as a whole. The author, by inference, does much to throw light upon the habits of Mousterian man, and it is noteworthy that he is inclined to regard a certain condition of the equine teeth as evidence for domestication. His most important contribution to anthropological science, however, was the discovery in 1911 of the human skeletal remains now known as the La Quina man, and in 1915 of the cranium of a child aged eight, both falling within the Neanderthal group. Dr. Martin, on the ground of inferiority to type in certain respects, is disposed to regard the former as female.

Practical Chemistry. By E. J. Holmyard. (Bell's Natural Science Series.) Pp. xvi + 267. (London: G. Bell and Sons, Ltd., 1923.) 4*s*. net.

MR. HOLMYARD in the preface to his book has something to say on the heuristic system, about which so much was said a few years ago. While we may admire it at a safe distance, he remarks, "We are at least upon safe ground when we believe that a little sound knowledge acquired by the method of direct teaching is distinctly more valuable than much hazy and inaccurate knowledge gained by the so-called 'method of research'—which is, of course, not the method of research at all, but a sort of game of make-believe." He has written a sound and useful book on the lines he advocates. It covers the ground of the School and Higher Certificate Examinations, and is sufficient for University Scholarships, but is wisely not written for any examination. Gravimetric and volumetric analysis, physical chemistry and organic chemistry are included, but the author has rightly, we think, omitted qualitative analysis. The course described is one of the best we have seen, and the book should become popular in schools. It is evidently the work of an experienced teacher.

Ink. By C. Ainsworth Mitchell. (Pitman's Common Commodities and Industries.) Pp. ix + 128. (London: Sir Isaac Pitman and Sons, Ltd., 1923.) 3*s*. net.

MR. MITCHELL has dealt with the origin of inks, the way in which they are made, and their characteristics in a most interesting and useful way. The use of carbon inks, he shows, dates back to very remote periods in Egypt and China. The earliest mention of iron-gall ink is said to be in the work of Theophilus the Monk, dating to about the eleventh century A.D. Before the beginning of the seventeenth century, ink was made in the household, but in 1609 it was manufactured in Paris, later in Dresden, and much later by Stephens in England. Mr. Mitchell deals with all kinds of ink, including printing ink.

Your Broadcast Receiver and How to Work It: Hints and Tips for the Radio Listener. By P. W. Harris. Second Impression. Pp. 68. (London: The Wireless Press, Ltd., 1923.) 6*d*. net.

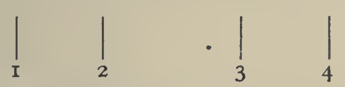
THIS book can be recommended to owners of broadcasting receiving sets. A judicious amount of elementary practical theory is given which will enable them to get the best results from their apparatus.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Regularities of the Spectral Lines of Iron and the Atomic Magnetic Field.

SINCE our short account of the method of observing the Stark effect with a stabilised arc was written (see NATURE, March 31, p. 431), we have made experiments on about twenty different metals. With elements having a simple spectrum, as silver, copper, zinc, and others, the separation of the lines into different series is facilitated from the similarity in the winged appearance of the lines in the strong heterogeneous electric field near the anode, though the broadening is generally asymmetric and there is some difference among the polarised components. The examination of many thousands of iron lines is not yet completed, but choosing lines between λλ 2400 to 3000 Å showing the simplest type of the effect, in which they are enhanced and slightly shifted towards shorter wave-lengths, we have found that a few lines can be arranged in regular triplets, quartets, and sextets. These mostly belong to spark lines. In addition to these regularities, we can arrange the enhanced lines into a large number of quadruplets as shown below:



The frequency difference, $\Delta\nu(1,2)$, is equal to $\Delta\nu(3,4)$ to a fraction of the wave-number per cm. The relations between $\Delta\nu(1,2)$ and $\Delta\nu(2,3)$ are various, but the values of $\Delta\nu(2,3)$ and $\Delta\nu(1,4)$, and especially those of $\Delta\nu(2,4)$ and $\Delta\nu(1,3)$, are common to many of the quadruplets.

The remarkable numerical relation between $\Delta\nu(1,2)$'s is that they come out in groups as given in the subjoined table:

Group.	No. of Quadruplets.	Mean $\Delta\nu(1,2)$, $\Delta\nu(3,4)$.	Range of $\Delta\nu(1,2)$.
a	14	59·6	55 to 68
b	15	111·7	106 to 121
c	46	182·4	171 to 197
d	34	245·3	230 to 262
e	6	362·9	354 to 372
f	47	422·4	414 to 435
g	15	484·9	477 to 495

Values outside the ranges above cited do not appear.

Counting from group (*a*), the mean $\Delta\nu(1,2)$'s, excepting the second, are almost exactly in the ratio

$$1:2:3:4:6:7:8.$$

It is singular that 5 does not enter in the above ratio; the absence of this number will probably underlie the principle of choice. Perhaps the above ratio has some bearing on the quantum theory, and is connected with the inner quantum number (" innere Quantenzahl "). If we interpret the existence of regular separations as due to the action of an atomic magnetic field, the above relation seems to be one aspect of Runge's rule in the Zeeman effect. Taking 363 as the standard separation, the above ratio can be written as representing 1/6, 1/3, 1/2, 2/3, 1, 7/6, 4/3. The intervals of quadruplets in group (*g*), for which $\Delta\nu(1,2)=485$, frequently occurs and is closely related with the separations of numerous quadruplets, so that it seems to have some important signification. The same number occurs in two regular triplets.

In forming these quadruplets, there is no criterion but that of taking the interval $\Delta\nu(1,2)=\Delta\nu(3,4)$, with corresponding symmetry in the intensity of lines. Analysing the distribution of lines, it is found that the same line can be looked upon as belonging to more than one quadruplet. Most of them are perhaps not real quadruplets, but belong to portions of more complex separations, the true nature of which is difficult at present to unravel. Dealing with many hundreds of lines, chance coincidences may frequently occur, yet the probability of the existence of regularities can scarcely be doubted. Eventually, we shall be able to arrange the iron lines in spectral series by utilising the Stark effect, if such really exist.

If we assume that the separations are due to the Zeeman effect of the atomic magnetic field, they will probably amount to aliquot parts of a normal triplet, if they follow Runge's rule. This is not usually obeyed in iron lines by applying an external field, but if we roughly assume that the triplets ($\Delta\nu(1,2)=485$) are normal, the field must amount to 10^7 gauss, which will approximately give the order of magnitude of magnetic force acting on the light-emitting electrons. As the above value of $\Delta\nu$ corresponds to the widest separation observed, the field will be generally smaller; by choosing $\Delta\nu=354$, which is found in one of the triplets and a number of quadruplets, the atomic field is found to be 6.6×10^6 gauss, coinciding with the value found by Weiss from experiments on magnetisation. This gives strong support to the magneton theory, and though the problem of atomic field is still in a hypothetical stage, the close agreement of the results obtained from measurements made on different phenomena is worthy of further consideration.

In Bohr's equation for calculating the frequency of light, the change of electric energy is taken into account only when an electron passes from one orbit to another during the emission of light. If we assume that, in the interior of an iron atom, a strong magnetic field as given above is prevalent, we must also examine the change of magnetic energy during the emission. This adds a further complication to the discussion, especially when the orbits are not coplanar. The question is, where does the magnetic field come from; does the seat lie in the nucleus or in the orbital motions of electrons? The intricate nature of the spectral lines in ferromagnetic metals may ultimately be traced to the existence of an inner atomic field.

The list of lines and different separations will be published shortly in the *Japanese Journal of Physics*, vol. 2.

H. NAGAOKA.
Y. SUGIURA.
Institute of Physical and Chemical Research,
Hongo, Tokyo, July 20.

Embryology and Use-Inheritance.

HAVING read with great interest in the supplement to NATURE of August 18 the Huxley lecture of my friend Sir Arthur Keith, and the comments upon it in " Current Topics and Events " of the same issue, I should like as an embryologist to make some remarks on the subject. Sir Arthur, in his fascinating style, describes the manner in which during development indifferent embryonic cells are marshalled so as to build up structures of functional and adaptational use. He arrives, however, at the surprising conclusion that " functional adaptation . . . is a property

resident in the embryonic tissues; the effects of usage in the parent can have no influence on the machinery."

Sir Arthur, therefore, if I understand him aright, comes out as a predestinarian orthogeneticist. The experiences of the animal have no influence in shaping the structure of its offspring. In this attitude he outdoes that ultra-mendelian Prof. Morgan, of New York, who, when confronted with the problem of the ultimate causes of his "mutations," admitted that no other source could be found for them except the influence of the environment.

What reasons does Sir Arthur adduce for what I may term his despairing conclusion? In the last analysis they reduce themselves to two, namely: (1) functional adaptations—such as the shape of the crowns of the molar teeth—and the separation of the peronæus tertius muscle from the extensor muscle of the little toe, come into existence in the embryo before there is any possibility of the performances of the functions to which they are adapted; and (2) Sir Arthur can conceive of no mechanism by which the habits of the parent can influence the embryonic machinery.

Now when Lamarckism is dismissed on grounds such as these, it would have been just as well if Sir Arthur had made himself acquainted with the form in which the Lamarckian theory is held by modern biologists. May I briefly refresh his memory? Modern Lamarckism may be stated as follows:

(1) An animal exposed to a new environment modifies its habits, so as to adapt them to new needs.

(2) New habits, persistently indulged in, entail modifications of adult structure.

(3) The offspring of animals which have adopted the new habit, if they remain in the same environment as their parents, tend to assume the new habits more quickly and on slighter stimulus than did their parents, and to develop the corresponding structures at an earlier period of their lives.

(4) Ultimately, when the new habits have persisted for a long time, *the corresponding structures make their appearance in development before the performance of the functions to which they are adapted.*

It is obvious, therefore, that all Sir Arthur Keith's arguments against "use-inheritance" are irrelevant to the question at issue. Sir Arthur is a brilliant mammalian embryologist. Were he a comparative embryologist he would be acquainted with cases which would stagger even him in his opposition to Lamarckism. I will give one. All Macruran crustacea (lobsters, prawns, shrimps, etc.), when seeking retreat, move backwards and strive to thrust the abdomen into a dark crevice. The hermit crabs have adopted the habit of inserting the abdomen into the curved passage of an empty gastropod shell, and in consequence the abdomen has become curved. The young hermit crab, however, in its last free-swimming stage has an abdomen as symmetrical as that of a shrimp; but when it sinks to the bottom, *before it has found an appropriate shell*, the abdomen has already become curved. Does Sir Arthur ask us seriously to believe that this curvature has been produced by some mystical "adaptational" mechanism among "embryonic cells," and has had no relation to parental habits? The paragraph in "Current Topics and Events" rightly states that the crux of the whole discussion is the proof of the actual existence of use-inheritance. Many of us believe that by means of well-thought-out and patiently executed experiments this proof has already been given. Those who refuse their assent may be divided into two classes, namely: (*a*) those who are unacquainted with the full details of the experiments; (*b*) those who are acquainted with these details and strive to escape from their inevitable consequences by attributing fraud to the experimenter. It is obvious from his sympathetic references to Kammerer that Sir Arthur Keith belongs to the first of these categories. May I recommend to him a more prolonged and extensive study of Kammerer's papers?

The paragraph in "Current Topics and Events" goes on to state that every failure to demonstrate use-inheritance strengthens the Darwinian position, which is adopted by the best and most philosophical workers in biology to-day. This is a statement which I frankly fail to understand. Darwin was until the close of his life a convinced believer in the existence of use-inheritance, although he did not regard it as the sole factor in evolution. Who are at present the best and most philosophical workers in biology is, of course, a matter of opinion: I should think that Darwin, if still with us, would put in this category those who had the widest acquaintance with facts. If this criterion be granted, then I may remark that the best palæontologists and the best systematic zoologists whom I know are strongly inclined to adopt the Lamarckian point of view.

Far be it from me to say a single word in disparagement of that great biologist Huxley, whom Sir Arthur Keith claims, and I have no doubt rightly, as a predeterminist. From Huxley I received my first attraction to the study of biology, and it has fallen to my lot to succeed him in his chair. I am convinced that if Huxley were still alive, and had learned from Sir Arthur Keith's brilliant exposition the wonderful facts of the indifference of embryonic cells, and their capacity at need to form any kind of tissue, he would find it difficult to persist in his conception of the "germ-plasm" as a machine-like mosaic of molecules.

Sir Arthur compares the embryonic cells to an army of workmen capable of various tasks whose energies are co-ordinated to a common end—not by a director but by hormones or chemical messengers which they send to each other. I must frankly confess that it baffles all my powers to conceive how, from an unorganised mob of undifferentiated cells, an organised structure could arise solely by their mutual influence. Certainly the amount of constructive work accomplished in these circumstances by a crowd of British workmen would be a minus quantity. Surely the influence which organises and marshals these cells must be one external to themselves. There must, in the developing embryo, be some part which takes the lead and emits the primary hormones which control the action of the rest. This I pointed out in my address to Section D of the British Association in 1916. May I illustrate this by an example taken from a recent paper by Ruud and Spemann with which Sir Arthur is possibly not acquainted? If a small portion of the developing nerve-plate of *Triton alpestris* be grafted into the ectoderm of a gastrula of *Triton tæniatus* in a region where normally the neural plate is not found, it will organise the ectoderm cells around it into a neural plate, in the midst of which it will be found, distinguishable from the cells of the host by its different colour.

Let me in conclusion suggest to Sir Arthur Keith that these primary hormones or "formative stimuli," which initiate development and give it its course, are the physical correlates and bearers of the *memories* of the race, stored in the egg-cell which has in turn received them from the tissues of the parent generation.

E. W. MACBRIDE.

As I read over the homily which my friend Prof. MacBride has addressed to readers of NATURE in general and to myself in particular—one with which we are all becoming familiar—I was reminded of an

experience suffered by Huxley when he lectured at the Royal Institution on the cerebellum. At the end of the lecture, a devout hearer approached to inform him that she had understood and enjoyed the lecture —with the exception of one point—was the cerebellum inside or outside the skull? After I have filled 24 columns of your valuable space to prove that Huxley was altogether right when he denied that use-inheritance played any part in the evolution of man—or of any other animal—Prof. MacBride, after reading these columns, turns round and practically asks me if I have heard of Kammerer!

If Prof. MacBride will be so good as read my Huxley lecture again, he will see that I neither affirm nor deny the doctrine of use-inheritance What I have denied, in as clear terms as are in my vocabulary, is that Lamarckism—whether of the original 1809 vintage or of the brand bottled in 1923 by Prof. MacBride—has had no part in the evolution of man. To give my reasons for this conclusion would compel me to inflict on the readers of NATURE a repetition of my Huxley Lecture. Here I must content myself by saying that Lamarckism gives no explanation of man's developmental history, none of his anatomy; it leaves the ancestral forms of man, such as we know of from the discovery of their fossil remains, unexplained; it cannot explain the characters which differentiate one racial type of modern man from another. In brief, the tenets which Prof. MacBride clings to with such fidelity cannot serve the purposes of even a working hypothesis for the modern anthropologist.

Prof. MacBride is good enough to suggest that I should be staggered did I know of certain facts with which comparative embryologists are familiar. Well, I do sometimes make little excursions into the realms of invertebrate embryology and frankly confess I am staggered by the fact that men who are familiar with the developmental histories of invertebrate animals can have any belief of Lamarckism as a factor in evolution. ARTHUR KEITH.

Solar Activity and Atmospheric Electricity.

DR. BAUER'S courteous attempt (NATURE, August 11, p. 203) to reconcile our views respecting the connexion he believes in between sun-spots and atmospheric electricity calls for a reply. I should first explain that we differ as regards even the connexion between sun-spots and terrestrial magnetism. Apparently we both accept the relation

$$R = a + bS \quad . \quad . \quad . \quad . \quad (1)$$

between R, the range of the regular diurnal variation for the year, and S, the sun-spot number. Here a represents the range for no sun-spots and $100b$ the increase in range for a sun-spot frequency of 100. The value of $100b/a$ varies with the magnetic element and with the station, but is usually in the neighbourhood of 0·8. The further relation mentioned by Dr. Bauer, p. 204, "an increase of 100 in the sun-spot number would correspond to a decrease in the intensity of magnetisation of the earth of about 0·1 per cent.," is not a result I consider proved. If it were true, there should be a decided 11-year period in the secular change. Claims to have established such a period have been made, but seem to me to have broken down. Quite recently failure to detect the phenomenon at Paris, one of the most satisfactory stations, has been announced by M. A. Angot (*Ann. de l'Institut de Physique du Globe*, Paris, 1923, p. 288). But if Dr. Bauer and I are not exactly at one on this point, we are at least agreed that the influence of sun-spots on the absolute values of the magnetic elements is exceedingly small, if not zero.

Coming now to the potential gradient of atmospheric electricity, Dr. Bauer claims to have established a *substantial* spot influence both on the amplitude of the diurnal variation and on the mean value for the year. In the Physical Society paper to which he refers (Proc. Phys. Soc., London, vol. 35, p. 129), I attempted to check the alleged sun-spot influence both for the diurnal range and the absolute value by means of formula (1). In the case of the absolute value, R represented the mean value of the potential gradient for the year. In addition to results from the Ebro Observatory, on which Dr. Bauer had mainly relied, I employed data from two periods of years at Kew, determining a and b in all cases by least squares. Except in one case the value found for $100b/a$ was positive, but it was much below 0·8, and the values found for the correlation coefficients were too small to warrant the conclusion that a true sun-spot influence had been made out.

In his recent letter Dr. Bauer does not impugn the accuracy of my mathematical work. What he does is to employ instead of (1) a formula of the type

$$R = a' + b'S + c'T \quad . \quad . \quad . \quad . \quad (2)$$

where S is now the difference of the sun-spot number from its mean value, and T the time in years counted from the middle of the period. We may, I think, treat it as a mathematical certainty that the observational results must be expressible *exactly* by a formula of the type

$$R - a' - b'S = f(T).$$

What Dr. Bauer has found is that for one particular period of years $f(T) = c'T$ gives a good result at certain stations, notably Ebro and Eskdalemuir, which he considers good, and a less good result at other stations, Potsdam and Kew, which he considers inferior. He would no doubt get a still better result if he put

$$f(T) = c'T + d'T^2.$$

But is the goodness of fit in such a case any evidence of the real existence of a sun-spot influence? There might, for example, be an excellent fit with $b' = 0$.

There may admittedly be special conditions in which something is to be said for a formula of type (2). As I showed some years ago, the absolute value of potential gradient at Kew, and presumably elsewhere, is affected by the visibility (purity) of the atmosphere, potential falling as the visibility rises. If the purity of the atmosphere at a station improved at a uniform rate, potential gradient would naturally fall, and it might be a proper course to apply a corrective term $c'T$, with c' negative as found by Dr. Bauer at the Ebro, Eskdalemuir, and Kew. Again, if a station went on applying an invariable factor for the reduction to an infinite plane, while the factor was really altering owing to continuous deterioration of the insulation or other instrumental cause, a corrective term $c'T$ with c' negative might be justifiable if the rate of deterioration was constant.

The reasons assigned by Dr. Bauer, p. 203, for considering Kew an inferior station are the large size of c_2/c_1, the ratio of the amplitude of the 12-hour to the 24-hour Fourier wave, and the high mean value of potential. Now I can imagine another critic holding—and with equal reason—that a low value of c_2/c_1 and a low mean value of potential gradient are both symptoms of inferiority either in the site or in the apparatus. He might even suggest that the mean values at the Ebro, $86v/m$ in 1921 and $76v/m$ in 1922, are outstandingly low.

If a high mean potential gradient is a sign of

inferiority, the good character of Eskdalemuir seems difficult to explain, as the value there makes a much closer approach to the Kew than to the Ebro value, the latter being notably below what Dr. Bauer puts forward as the normal. Again, if a high value of c_2/c_1 is a sign of inferiority, is it not strange that c_2/c_1 is highest at Kew in summer when the potential gradient is lowest? Ebro and Eskdalemuir have a variable number of monthly quiet days, while at Kew with rare exceptions the number is uniform. Weather conditions usually reduce the number of quiet days used at Eskdalemuir below the Kew number 10. Thus *a priori* we should have expected Kew to be the station least affected by accidental irregularities. According to Dr. Bauer the sign of c' (his t) "may depend upon whether the sun-spot cycle . . . is below or above average development." Apparently he expects a revolutionary change from a steady fall to a steady rise and conversely! It is obvious that if a steady fall did go on at the Ebro at the rate obtained by Dr. Bauer we should before long have the potential gradient negative.

The fact that Dr. Bauer finds negative values for c' at all three stations, Ebro, Eskdalemuir and Kew, may possess some physical significance unrelated to sunspots. In my Physical Society paper I referred to volcanic dust as a possible natural agency influencing potential gradient over wide areas. Even the agency of man may influence a considerable area. Thus I had myself regarded the value for 1921 at Kew as exceptionally low, and attributed this at least in part to the abnormal purity of the English atmosphere brought about by the coal strike. At all events the mean value for 1922, unlike that at the Ebro, shows a substantial rise.

In view of Dr. Bauer's concluding remarks it may not be amiss to point out that the earth's atmosphere is generally believed to contain an equal and opposite charge to the earth's surface. Thus the total charge on the earth as a planet would seem to be *nil* whether a sun-spot influence exists or not.

C. CHREE.

August 17.

Colour Vision and Colour Vision Theories.

IN his letter published in NATURE of August 25, Dr. Edridge-Green seems to admit the accuracy of the deductions from the trichromatic theory which I made in the issue of August 4. But, in making these, I used no other postulate than that of the fact of normal trichromasy. In the sense in which the word is used, trichromasy is now a qualitatively and quantitatively proved fact, although at the time of its first assertion it was in considerable part hypothetical. Strict logical development (which may be mathematical when necessary, since mathematics is merely symbolised logic from this point of view) leads directly to the explanation of certain phenomena which Dr. Edridge-Green had thought to be unexplainable on the basis of trichromasy. If the logical developments are sound, the conclusions are inevitable. But he brings forward three other facts which he still considers to be inexplicable on the theory.

First; a man, stated to be completely "red-blind," can recognise red as easily as a normal-sighted person. From the trichromatic point of view one might say, Why not? No doubt the term "red-blind" might preferably be avoided, seeing that it is a relic of the "hard-atom" stage of the theory; but the theory does not give the result that a dichromat of that type cannot distinguish red light from other lights. The notion that it must do so is a survival of ideas held under the restrictions of the early applications of the theory.

Second: 50 per cent. of the dangerously colour blind get through the wool test. Again, Why not? The theory would only use the fact, if granted, to aid in further elaboration of the details of the visual peculiarities.

Third: the theory is said to fail to explain the class of colour vision which Dr. Edridge-Green denotes as trichromatic, in which yellow is not recognised, the region of the spectrum occupied by yellow hues being called red-green. I cannot occupy space here in showing how this is directly predictable as a possibility on the trichromatic basis. I have discussed it, and other such cases, in my book on colour vision. Dr. Edridge-Green says that, in this case, the intersection of the dichromatic curves should be shifted towards the red on the trichromatic theory, and they are not so shifted. The statement is mistaken. There is no such compulsion on the theory.

The statements in Dr. Edridge-Green's last two sentences are in complete agreement with the theory. He says also that the theory is burdened with self-inconsistent subsidiary hypotheses. Actually the theory is based, and based alone, on two postulates; the qualitative postulate of trichromasy, and the quantitative postulate of the intensity law. All further development is straightforward, any definite constructive presumption being used in illustration only, and being clearly stated by Helmholtz to be quite inessential. In fact, he left the theory totally unburdened with fixed presumptions regarding structure and function. The fixation was to come later, probably by way of many supplemental theories consonant with it. All, including the views of Dr. Edridge-Green, may possibly help.

I would appeal to Dr. Edridge-Green not to pit his views against the trichromatic theory, but rather to consider wherein they may supplement it. Multichromasy higher than triple is without evidence. If he accepts Dr. Houston's work as the mathematical expression of his views, he thereby makes them trichromatic in the usual sense of the term. His views may supplement the theory on the side of functional physiology or psychology; they cannot refute it on the formal side.

W. PEDDIE.

August 25.

The Phosphate Deposit of Ocean Island.

ON p. 787 of NATURE of June 9, which has just reached me, a notice appears, under the heading of "Mineral Fertilizers," of my paper on "The Phosphate Deposit of Ocean Island" (Quart. Journ. Geol. Soc., vol. lxxix., p. 1, 1923.)

As this notice misinterprets certain of the statements made in the paper, I beg the courtesy of your space for the necessary corrections.

(1) One of the points emphasised in the paper is the gradual and uniform change which occurs in the composition of the deposit as one passes from perimeter to centre. This change is so regular that it can be expressed by a simple formula.

There is no normal 88 per cent. and no "level . . . where the phosphate sinks from its normal 88 to 79 per cent.," the change being gradual and without break from 79 to 92 per cent.

(2) The deposit cannot be truly described as having "a depth of fully fifty feet." As stated in the paper, it is sometimes as much as 80 feet thick, but usually less than 50 feet.

(3) The excess lime shown by analysis (*i.e.* the lime over and above that required for the phosphoric, carbonic, fluoric, and sulphuric acid radicals) varies

directly with the percentage of organic matter and inversely with the percentage of tricalcium phosphate. It is therefore more rational to assume that this lime is combined with the organic matter than to state (as has been done) that it is present as a compound of the type $x(Ca_3P_2O_8).y(CaO).zH_2O$.

Dahllite, $4Ca_3P_2O_8.2CaCO_3.H_2O$, is not mentioned in my paper. The idea of its occurrence is not rejected by me, however, as its presence is not in conflict with the chemical analyses, no excess lime (as defined above) being required for it.

That the calcium fluoride shown in the analyses (about 3 per cent.) is present combined as apatite to any considerable extent is unlikely, from the behaviour of the phosphate to reagents; the purer varieties of Ocean Island phosphate being, for example, almost completely soluble in cold, dilute hydrochloric acid.

Launcelot Owen.

Monteria,
Republic of Colombia,
South America, July 21.

I hope that no one who consults Mr. Owen's interesting paper will have been much troubled by misinterpretations on my part. The words "normal 88 per cent." are based on the analysis on p. 13 of the paper, which is said to be "representative" and gives 87·5 per cent. I hope, again, that no reader of my note would suppose that a level exists in the rock at which the phosphate-content drops suddenly to 79 per cent. I should have written "has sunk" for "sinks."

In suggesting on p. 13 of the paper, and in his letter, that lime is associated with the organic matter in the phosphate, Mr. Owen raises a question of wide importance. The special adsorptive influence of organic colloidal gels in soils is now well known, and Mr. Owen doubtless sets a good example in not presuming the presence of dahllite or any other mineral unless it can be recognised by specific characters in the mass. The rather delicate fibrous crystallisation of dahllite may be looked for. We must remember that A. Lacroix and other mineralogists recognise definite species of mineral "calcium carbo-phosphates." E. Blackwelder, on the other hand (*Amer. Journ. Sci.*, ser. 4, vol. 42, p. 294, 1916), regards the less definite collophane as the common product of the reaction between phosphoric acid and lime salts, especially calcium carbonate, in the presence of ammonia. Collophane, as Rogers shows, can associate fluorine with its colloidal substance, and may thus suggest the presence of apatite. In his researches on the chemistry of phosphatised reefs, Mr. Owen is opening up a very interesting petrological field.

The Writer of the Note.

The Metric Campaign.

In reviewing Drury's "World Metric Standardisation" (Nature, August 18, p. 234), the statement is made that "far less opposition has been raised to the adoption of the litre and gram than to the metre, which is very much more closely related to industrial processes than the units of mass and measure."

Perhaps the following will serve to indicate to metric campaigners why those who are directly interested in industrial processes are in such an impenetrable fog over the question.

A few days ago, in a retail tool shop in a provincial town, I was shown a narrow steel measure, in four folding sections, the total length being one foot, which was divided into 305 minor, and 30½ major and numbered divisions, the first two engraved thus:—1|meter|2, so that to the purchasers of such an instrument 30½ metres are represented as equivalent to 12 *inches, instead of* 100 *feet*! The stock included the carpenter's ordinary foot-rule, divided along one edge into inches and sixteenths of an inch, and the other into millimetres and 30½ (centi)metres. All the shopkeeper could say was that the scales were as supplied by the best makers, and must therefore be accepted as correct—the word *meter* had no other meaning than that the makers used it instead of saying the scale was French!

Four years ago, in a western London suburb, I had exactly the same experience, but if my memory serves me the makers were different. The shopkeeper informed me that in his two shops (one nearer the West End) he had already sold many hundreds of these scales.

From time to time the London and provincial Press report meetings at which there have been discussions on the great advantages of the metric system, but there the matter ends—apparently it is nobody's business, not even of the Board of Trade or the Board of Education, to take action which would ensure the circulation of correctly marked scales. All the wrongly engraved ones ought to be recalled, to have *centi-* engraved above *meter*.

Hy. Harries.

August 20.

Direction of β-rays Produced by Polarised X-rays.

In an abstract (Nature, July 7, p. 26) of a paper read recently before the Royal Society, Mr. C. T. R. Wilson discusses some results on β-ray ionisation tracks which he has obtained by his cloud method. Among other things he notes (1) "Partial polarisation of the primary beams is indicated by the direction of ejection of a number of the β-particles being in one plane—that containing the direction of the cathode rays in the X-ray tube," and (2) "Of the ordinary long-range tracks, the majority have a large forward component comparable with the lateral component."

During the past year the present writer, using a beam of scattered X-rays about 90 per cent. polarised (Wilson's primary beam was probably about 10 per cent. polarised), has obtained stereoscopic photographs of β-ray ionisation tracks by the cloud method. These photographs show that most of the β-particles are ejected in a direction nearly parallel to that of the electric force of the polarised beam of X-rays. There is, however, a variation on either side of this direction.

The photographs also support Wilson's conclusion that a large majority of the β-particles have a velocity component in the direction of propagation of the X-rays.

F. W. Bubb.

Washington University, Saint Louis,
July 30.

Proposed International Survey of the Sky.

I am informed by the director of the Office National Météorologique de France that, with the approval of Sir Napier Shaw, president of the International Commission for the Study of Clouds, the dates for taking the photographs of clouds have been postponed by one week. Photographs will be taken at the three specified hours from September 24 to October 1 inclusive. Volunteers are much needed to help in the work, and I shall be glad to send full instructions to those who will send me their names.

C. J. P. Cave.

Stoner Hill, Petersfield, Hants,
August 27.

Gaseous Combustion at High Pressures.[1]

By Prof. W. A. BONE, F.R.S.

INTRODUCTION.

IN the course of the researches upon gaseous combustion which for many years past have been carried out in my laboratories, it became necessary to study the subject under much higher pressures than those heretofore employed. As this aspect of the work has recently assumed greater importance from the point of view of the mechanism of combustion than was at one time foreseen, an outline of it may be of interest. Before, however, explaining what our new observations have been, something should be said about the apparatus and methods employed for such work. For they must obviously differ from those used for experiments at atmospheric pressure, where the conditions are much less severe.

In the first place, the experiments must be carried out in specially designed bombs of forged steel capable of withstanding the sudden development of very high explosion pressures. Thus, in our recent experiments, the initial pressure at which the combustible mixtures were fired ranged up to 100 atmospheres; and the resulting pressures, which were developed in a small fraction of a second, were anything up to ten times as great. Hence the method of measuring and recording the pressures must be capable of following accurately, and with the least possible lag, a rise of pressure of from (say) 100 to 1000 atmospheres occurring within $\frac{1}{200}$th of a second. For this purpose we have employed a recording manometer of the form designed by Sir J. E. Petavel, which is a most efficient appliance for high-pressure explosion work.[2]

The photographic pressure-time records obtained in our experiments show (1) the rate at which the potential energy of the explosive mixture fired is transferred into kinetic (*i.e.* pressure or temperature) energy of the products; (2) the ratio of the maximum pressure attained on explosion to the initial pressure at which the mixture was fired—usually denoted as P_m/P_i; and (3) the rate of the subsequent cooling. From a study of these and other features of the records we are able to draw conclusions as to certain fundamental aspects of the combustion process itself.

SOME FEATURES OF THE COMBUSTION OF HYDROGEN AND OF CARBON MONOXIDE IN AIR.

As an example of the potentiality of high-pressure explosion research to reveal and elucidate new factors in gaseous combustion, I propose to deal mainly with the cases of hydrogen and carbon monoxide. For although at first they may seem to be of the simplest type, yet they present features of extraordinary interest and complexity which for many years past chemists have vainly tried to explain. Even engineers, who study internal combustion problems in their own way, without troubling themselves overmuch with the mechanism of the chemical changes involved, are seeking light upon what is termed the "suppression of heat" in such explosions. Indeed our present ignorance about these matters shows how far we are from really understanding the elements of gaseous combustion, and the need there is of much further fundamental research thereon.

From a chemical point of view there has always been something enigmatical about the very different behaviours of the two simplest combustible gases, hydrogen and carbon monoxide, when burning in air. For although their volumetric heats of combustion (assuming the initial and final temperatures being both about 15° C.) and the proportion by volume in which each of them combines with oxygen are the same, namely:

$$\left.\begin{array}{l} 2H_2 + O_2 = 2H_2O \quad \ldots \quad 68{\cdot}4 \\ 2CO + O_2 = 2CO_2 \quad \ldots \quad 68{\cdot}0 \end{array}\right\} \text{K.C.U. per gram-molecule,}$$

yet in many respects their modes of combustion in air present a striking contrast.

Thus, for example, (1) the appearance of a flame of hydrogen in air is very different from the lambent blue flame of carbon monoxide burning at the same orifice and under the same pressure; (2) hydrogen-air mixtures have lower ignition temperatures, and, under similar physical conditions, propagate flame much faster than the corresponding carbon monoxide-air mixtures; (3) the presence of even a minute quantity of steam greatly assists, if it is not absolutely essential to, the oxidation of carbon monoxide in flames, even when detonation is set up—thus a flame of the dry gas is easily extinguished on being introduced into a jar of air that has been previously dried over strong sulphuric acid; (4) a flame of carbon monoxide burning in air loses by radiation nearly 2·4 times as much energy as a hydrogen flame of the same size; also (5) the two radiations have their own characteristic wave-lengths—namely, 2·8 μ from a carbon monoxide-air flame and 4·4 μ from a hydrogen-air flame—which have been attributed to vibrational conditions in incipiently formed CO_2 and HO_2 molecules respectively, or, as I prefer to say, to the formation *at the moment of combustion* of intensely vibrating carbon monoxide-oxygen and hydrogen-oxygen complexes, which ultimately give rise to carbon dioxide and steam molecules respectively.

To summarise: carbon monoxide burns in air more slowly and with a more highly radiating flame than does hydrogen; also apparently the presence of some steam or other hydrogen-containing substance is necessary for its combustion. Precisely how steam accelerates or determines the combustion of carbon monoxide (and only a minute quantity suffices) has up to now never been completely explained; but chemists are generally agreed that carbon monoxide molecules are particularly inert towards oxygen molecules in flames. Indeed I think there are grounds for believing that in ordinary flames carbon monoxide cannot react with undissociated oxygen molecules, but that it requires the presence of either :O atoms or "activated steam" :OH_2 molecules.

[1] From a discourse delivered at the Royal Institution on Friday, May 11.
[2] A full description of the bomb and accessory appliances will be found in Phil. Trans. Roy. Soc., A 215 (1915), pp. 275-318.

HIGH-PRESSURE EXPERIMENTS.

Bearing the foregoing considerations in mind, let us now see what new light has been shed on the problem as the result of high-pressure combustion research. Here it should be pointed out that, inasmuch as the chief difference between the condition of high- and low-pressure experiments lies in the absolute concentration of the interacting molecules, it may be expected that factors the operation of which chiefly depends on such concentration will become more dominant as the pressure arises. Indeed, the value of high-pressure work lies in the fact that it tends to show up and accentuate the operation of factors the influence of which may be either masked or overlooked at ordinary pressures.

One of the first things disclosed by our experiments was the absence of any direct relation between the rate at which the potential energy of an explosive mixture is transferred on explosion to its products as sensible heat (pressure) and the magnitude of the chemical affinity between its combining constituents. Thus, for example, the time required for the attainment of maximum pressure on exploding at 50 atmospheres a methane-air mixture ($CH_4+O_2+4N_2$), in which the combustible gas and oxygen are present in equimolecular proportions (*i.e.* corresponding to the primary chemical interaction in the flame), was many times longer than that required in the case of the corresponding hydrogen-air mixture ($2H_2+O_2+4N_2$), notwithstanding the fact that the affinity of methane is at least twenty, and possibly as many as thirty, times as great as that of hydrogen for oxygen in flames. In other words, the avidity with which a combustible gas seizes upon oxygen in flame combustion is not necessarily the factor which mainly determines the rate at which the potential energy of the mixture is transferred into kinetic energy of its products.

Later experiments have chiefly dealt with the explosion usually at an initial pressure of 50 atmospheres of what may be termed isothermic mixtures of either carbon monoxide or hydrogen with sufficient oxygen for complete combustion *plus* some variable diluent developing as nearly as may be the same amount of energy on combustion. I will now endeavour to explain their significance.

THE CONTRAST BETWEEN CARBON MONOXIDE-AIR AND HYDROGEN-AIR PRESSURE CURVES.

We may appropriately begin with a consideration of two typical pressure-time records (Fig. 1) obtained when normal carbon monoxide-air and hydrogen-air mixtures ($2CO+O_2+4N_2$ and $2H_2+O_2+4N_2$) were respectively fired in the bomb at an initial pressure of 50 atmospheres.

Now, although these two mixtures developed as nearly as may be the same total amount of energy on explosion, there was a striking contrast between the character of the pressure-time curves obtained. For whereas in the typical hydrogen-air curve the pressure rose with extreme rapidity (actually in 0·005 second) to its maximum (about 400 atmospheres), and almost immediately thereafter began to fall and assume the character of a simple cooling curve, in the corresponding carbon monoxide curve the pressure rose much more slowly and only attained a maximum (about 410 atmospheres) after 0·18 second, after which it was maintained almost at its maximum for a considerable time interval. The comparative slowness with which pressure energy is developed in such a carbon monoxide-air explosion, together with a considerable exothermic effect after the maximum pressure had been reached, were indeed very remarkable and significant features of our experiments. At first we were inclined to attribute them to the supposed "slow-burning" property of carbon monoxide as compared with the "quick-burning" of hydrogen; but further experiments revealed the operation of another totally unexpected factor—namely, the presence of nitrogen, which, as we discovered later, is not inert but acts as an "energy-absorber" in the combustion of carbon monoxide at such pressures.

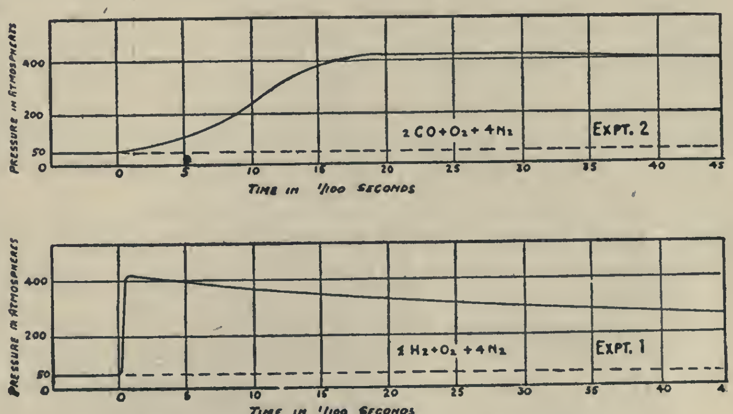


FIG. 1.—Pressure-time records for the explosion of carbon monoxide-air and hydrogen-air mixtures.

EFFECT OF ADDITION OF HYDROGEN UPON THE CARBON MONOXIDE-AIR CURVE AND UPON A CARBON MONOXIDE FLAME BURNING IN AIR.

It was next discovered that the replacement, even in very small proportions, of carbon monoxide by its equivalent of hydrogen in the aforesaid normal carbon monoxide-air mixture had a disproportionately large influence in accelerating the rise of pressure on explosion. This remarkable result, which is of considerable theoretical import, was dealt with at length in a paper published two years ago by the late W. A. Haward and myself in the Proceedings of the Royal Society.[3] Indeed at first sight it seemed as if the hydrogen had imposed its own character upon the whole course of the carbon monoxide combustion, even when the combustible part of the mixture exploded contained only one part of hydrogen to twenty-three parts of carbon monoxide by volume.

In this connexion it may be mentioned that the addition of a moderate amount of hydrogen to carbon monoxide burning in air at ordinary pressure has a considerable effect upon the character and spectrum of

[3] Proc. Roy. Soc., A. 100 (1921), pp. 67-84; see also a further paper in the current (August) number of the Journal of the Chemical Society.

the flame, a circumstance which seems to be of some significance in relation to the mechanism of carbon monoxide combustion. In conjunction with Prof. A. Fowler, of the Imperial College, South Kensington, we are now investigating it more closely with the view of finding out its meaning. But the facts known warrant us in concluding that the addition of a comparatively small proportion of hydrogen has a peculiar influence upon the combustion of carbon monoxide, whether at high pressures (as in our bomb experiment) or in flame combustion at ordinary pressures.

THE MECHANISM OF THE COMBUSTION OF CARBON MONOXIDE.

To explain the peculiar influence of hydrogen or steam upon the combustion of carbon monoxide, I think it must be supposed that oxygen and carbon monoxide molecules are mutually inert in flames, and that before the carbon monoxide can be oxidised the O_2 molecules must be resolved either into O atoms or into "activated" steam. This precedent condition can be brought about by the presence of hydrogen (or maybe steam) in the mixture undergoing combustion. For, according to my present view, an undissociated O_2 molecule on being heated in the flame has its "residual affinities" sufficiently stimulated to enable it to seize upon two hydrogen molecules, forming initially an unstable vibratory complex H_4O_2. Such a complex, being in an intensely vibratory condition, would instantly break down (1) *partly* into two molecules of steam, also in a vibratory (and therefore "activated") condition, and (2) partly also into two : O atoms and two H_2 molecules, thus :

$$100\left(\begin{array}{c} O\langle^{H}_{H} \\ \| \\ O\langle^{H}_{H} \end{array}\right) \begin{array}{c}\text{would give rise to}\\ \text{(simultaneously)}\end{array} \left\{\begin{array}{l} (1)\ n \times 2 : O\langle^{H}_{H} \\ (2)\ (100-n)\ (2O : +2H_2). \end{array}\right.$$

The ratio $n/(100-n)$ would obviously depend upon both temperature and environment. The higher the temperature and the less hydrogen in the environment the less the magnitude of n. But in all conditions the hydrogen in a combustible mixture containing also carbon monoxide functions as a resolver of O_2 molecules simultaneously into (1) "activated" steam and (2) : O atoms. Thus it is suggested that the primary function of hydrogen as a promoter of the combustion of carbon monoxide is to resolve the O_2 molecules (inert towards carbon monoxide) into : O atoms and "activated" OH_2 (reactive towards carbon monoxide), itself being continuously regenerated in the process, as is shown in Fig. 2.

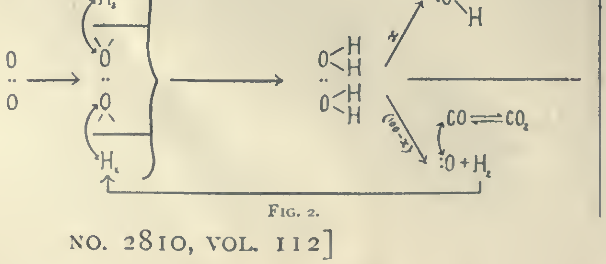


FIG. 2.

It may be observed that this view is similar to the one advanced forty years ago by Prof. H. B. Dixon to explain his discovery of the mutual inertness of dry carbon monoxide and oxygen in flames, but modified in one particular so as to make it more applicable to the further facts now known. He supposed that carbon monoxide is oxidised by OH_2 (but not by O_2) molecules in flames, the resulting hydrogen being immediately burnt to steam, which was thus continuously regenerated, as follows :

$$\left\{\begin{array}{l} (a)\ CO + OH_2 = CO_2 + H_2 \\ (b)\ 2H_2 + O_2 = 2H_2O \end{array}\right\}.$$

If, however, only such interactions (and no others) occur, it is difficult to understand why the colour and spectrum of a flame of pure (moist) carbon monoxide are so unlike those of hydrogen burning in air. The characteristic spectrum of a carbon monoxide flame, which extends far into the ultra-violet, would surely seem to be due to the formation in it of some CO_2 molecules in a more highly vibratory state than would be likely to arise merely by interactions of CO and OH_2 molecules. The difficulty in question is obviated, and also other facts would be better explained, by supposing (as I do) that an unstable vibratory H_4O_2 complex, primarily formed by the interaction of O_2 and H_2 molecules, decomposes in each of two ways yielding : OH_2 and : O atoms, both of which are capable of oxidising carbon monoxide.

THE ENERGY-ABSORBING FUNCTION AND ACTIVATION OF NITROGEN IN THE COMBUSTION OF CARBON MONOXIDE.

It next occurred to us to try the effects of progressively replacing the nitrogen of a normal carbon monoxide $(2CO + O_2 + 4N_2)$ mixture by molecular equivalents of other gases, *e.g.* oxygen, carbon monoxide, or argon. The first two of these gases are diatomic, and would have much the same densities and heat capacities as the nitrogen which they replaced ; and although they might be expected to exert some "chemical mass" influence upon the combustion, yet in all other respects they would act as "diluents." In argon we had an absolutely inert monatomic gas of higher density, but smaller volumetric heat capacity, than nitrogen, and incapable of any internal vibrational energy. It would therefore presumably be incapable of exerting any effect upon the explosion other than that of merely sharing, by molecular collisions, in the increased kinetic energy acquired by the system as the result of the combustion.

It may be observed that while the said replacement of the nitrogen by the other gases would not affect in any way the total energy liberated on explosion, yet the experiments showed that it affected somewhat the proportion of the energy recorded by the gauge as pressure (temperature) at the instant of maximum pressure, and still more so the rapidity with which the said pressure energy was developed. The most important experimental results from this point of view are summarised in the following table, and illustrated by the set of pressure-time curves reproduced in Fig. 3. Here it may be pointed out that the most essential

data which must be established in such experiments are the following:

P_i = the initial pressure in atmospheres at which each mixture is fired.

P_m = the maximum pressure in atmospheres recorded in the explosion.

t_m = the time in seconds required for the attainment of the maximum pressure after ignition.

Σ = the thermal equivalent in K.C.U. of the energy liberated during the explosion.

Also the percentage amount by which P_m falls during (say) 0·5 sec. after t_m.

Mixture exploded.	Σ.	P_i.	t_m.	P_m.	P_m/P_i.	Per cent. Fall in Pressure in 0·5 sec. after t_m.
$2CO+O_2+4N_2$	10·2	50	0·190	409	8·18	11·6
$2CO+O_2+4O_2$	10·0	50	0·005	460	9·20	33·33
$2CO+O_2+4CO$	10·4	50	0·010	450	9·00	34·3
$2CO+O_2+4Ar$	10·2	50	0·025	510	10·20	26·4

These and other similar results led very decidedly to the conclusion that the nitrogen present in the normal carbon monoxide-air mixture had been exerting a specific influence on the whole course of events, which was manifested in a three-fold effect upon the pressure curves—namely, (1) a marked retardation of the rate of attainment of maximum pressure, (2) a lowering of the maximum pressure, and (3) a considerable retardation of the subsequent cooling. For whenever such nitrogen was wholly replaced by its molecular equivalent of any one of the other three gases, the development of pressure became nearly as rapid as in the explosion of a normal hydrogen-air mixture under like conditions. Moreover, comparative analyses of the pressure-time records obtained during the experiments in question have shown that, when nitrogen was present, much less kinetic (pressure) energy was absorbed up to the attainment of maximum pressure than was subsequently liberated during the cooling period. This remarkable circumstance shows that a considerable part of the radiation emitted by the burning carbon monoxide (which otherwise would have been absorbed by the walls of the explosion vessel) was intercepted by the nitrogen present. Part of the nitrogen so irradiated would then, in favourable circumstances, be oxidised to nitric oxide, thereby absorbing part of the kinetic energy developed by the explosion and consequently reducing the maximum pressure attained. Finally, the radiant energy so absorbed by the nitrogen, *plus* part of the kinetic energy (if any) absorbed in forming nitric oxide during the combustion, was liberated as kinetic energy during the cooling period, so delaying the cooling. Thus it was manifest that under our experimental conditions nitrogen has the power of absorbing part of the radiant energy developed by the combustion of carbon monoxide, and of slowly giving it out again in a kinetic form during the subsequent cooling period. In other words, nitrogen is not inert, but acts as an "energy absorbing" spring in such explosions. Indeed the results set forth in the foregoing table can scarcely be explained on any other supposition.

Another important conclusion arising out of these experiments is that when nitrogen so absorbs radiant energy developed during a carbon monoxide-air ($2CO + O_2 + 4N_2$) explosion under such conditions, it becomes chemically "activated," and capable of combining much more readily with oxygen than does nitrogen which has merely been raised to a correspondingly high temperature in a similar hydrogen-air ($2H_2 + O_2 + 4N_2$) explosion. Indeed, when the bomb was rinsed out with distilled water after one of our hydrogen-air explosions at an initial pressure of 50 atmospheres, no more than a faint trace of nitric acid could be detected on applying the diphenylamine test to the washings; whereas, in the case of the corresponding carbon monoxide-air explosions, a similar test always showed a considerable formation of nitric acid.

It would seem as though the nitrogen molecule is able to absorb the particular quality of radiation emitted as the result of the interactions of CO and :O during a carbon monoxide-air explosion, which is different from that emitted during a hydrogen-air explosion. In other words, it seems as though there is

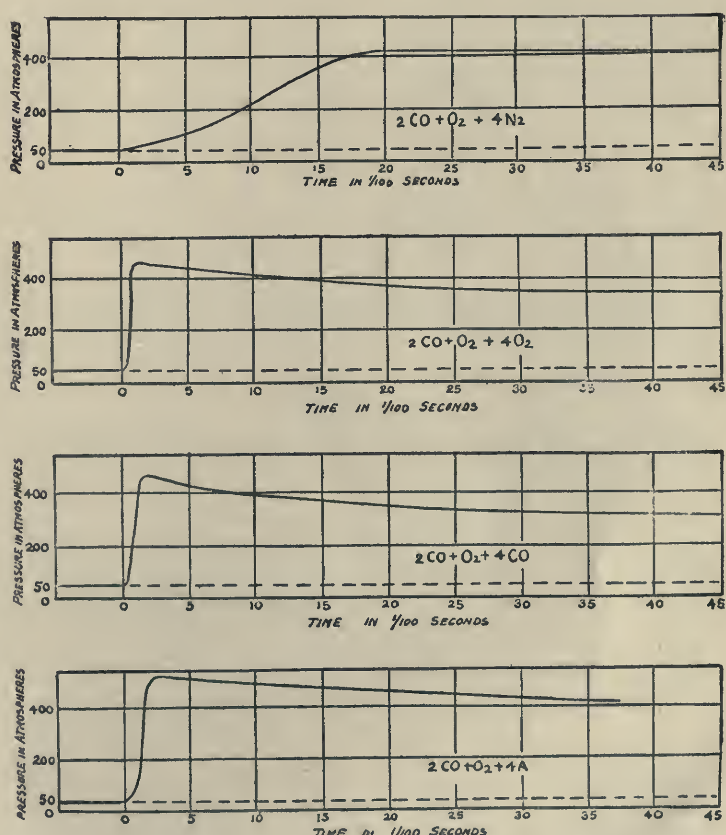


FIG. 3.—Pressure-time records for the combustion of carbon monoxide using different diluents.

some constitutional correspondence between CO and N_2 molecules (the densities of which are identical) whereby the vibrational energy (radiation) emitted when the one burns is of such a quality as can be readily absorbed by the other, the two thus acting in resonance. The radiant energy so absorbed during the explosion presumably would not affect the maximum pressure attained, except in so far as the conditions permitted of any secondary oxidation of the "activated" nitrogen to nitric oxide during the actual combustion period; but radiant energy so absorbed would be liberated in a kinetic form during the subsequent cooling period, as the "activated" nitrogen slowly reverted to the ordinary form. Analyses of the pressure-time records obtained have entirely confirmed this supposition.

The following graphs (Fig. 4) illustrate the strength of the evidence obtained up to this point as to the activation of the nitrogen during a carbon monoxide-air explosion at high pressures. They show the rates of cooling (expressed as pressure fall in atmospheres per second) of the gaseous systems immediately after the attainment of maximum pressure, when each of the four mixtures, $2CO+O_2+4N_2$, $2CO+O_2+4O_2$, $2CO+O_2+4Ar$, and $2H_2+O_2+4N_2$, were exploded in the bomb at an initial pressure of 50 atmospheres.

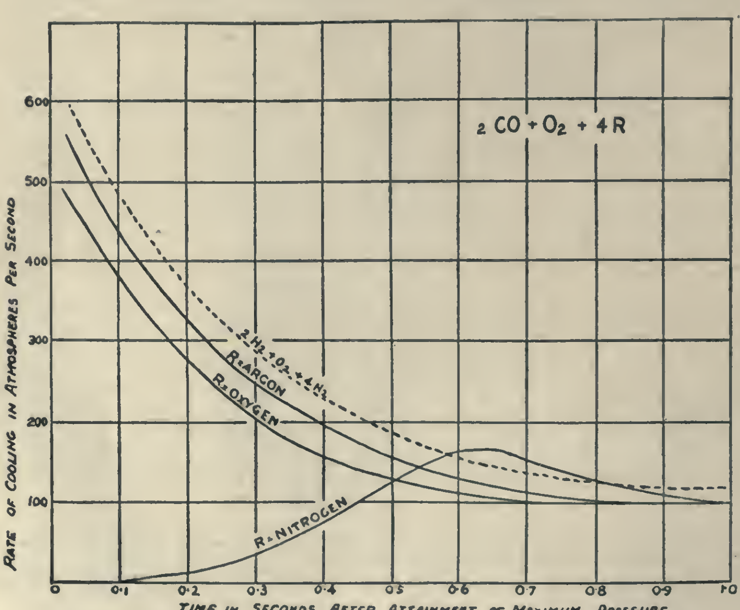


FIG. 4.—Rate of cooling after combustion of carbon monoxide using various diluents.

It will be seen that, except in the case of the carbon monoxide-air mixture, the cooling was perfectly regular, and presented no abnormal features whatever. In the case of the $2CO+O_2+4N_2$ mixture, however, there was no cooling at all during the 0·1 sec. after the attainment of the maximum pressure; and it was not until the lapse of the 0·6 sec. thereafter that anything like a normal rate of cooling was established. Attention is specially directed to the striking contrast between the perfect normality of the first 0·6 sec. of the cooling period in the case of the hydrogen-air ($2H_2+O_2+4N_2$) mixture, and its complete abnormality in the case of the corresponding carbon monoxide-air mixture. This circumstance, combined with the perfect normality of the cooling in the case of the $2CO+O_2+4Ar$ mixture, can scarcely be explained except on the assumption that the nitrogen functions differently in a hydrogen-air explosion, where it acts as an inert diluent only, from what it does in a carbon monoxide-air explosion, where in addition to its ordinary diluent action it has a peculiar energy-"absorbing" effect, whereby it becomes chemically "activated." On such an assumption the meaning of the $2CO+O_2+4N_2$ cooling curve is that the radiant energy which had been absorbed by the N_2 molecule during the previous combustion period was being slowly evolved in a kinetic form far into the subsequent cooling period, the "activated" nitrogen not having entirely reverted to its normal condition until at least 0·6 sec. after the end of the combustion period.

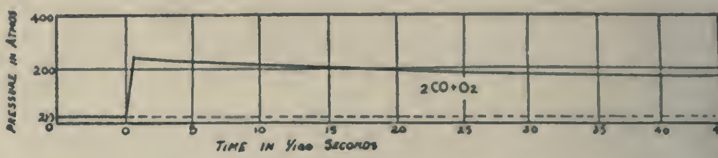


FIG. 5.—Pressure-time record of carbon monoxide-oxygen explosion.

EXPERIMENTS WITH SOME ISOTHERMIC MIXTURES.

Much confirmatory evidence of the radiant energy-absorbing function and consequent "activation" of nitrogen in the combustion of carbon monoxide at high initial pressures has been obtained as the result of experiments in which mixtures of carbon monoxide and oxygen in their combining proportions, diluted with successive molecular proportions (2, 4, or 6) of the four diluents, argon, carbon monoxide, oxygen, or nitrogen, were fired at such initial pressures as would always result in the liberation of the same total energy (about 10 K.C.U.) during the subsequent explosion. For details of these experiments the reader is referred to the memoir recently published in conjunction with my co-workers (D. M. Newitt and D. T. A. Townend) in the Proceedings of the Royal Society, A. 103, pp. 205-232. There is, however, a significant feature about the pressure-time records (Fig. 5) obtained when an undiluted $2CO+O_2$ mixture was fired in our bomb at an initial pressure of 21·4 atmospheres, to which reference should here be made, because of its bearing on the theory of CO-combustion.

It will be seen that the maximum pressure (245 atmospheres) was developed in 0·005 sec., after which the cooling period immediately set in; the pressure fall during the next 0·5 sec. being 66 atmospheres, or about 27 per cent. of the maximum. It is evident that an exceedingly high temperature was momentarily attained in this experiment; indeed, assuming that the

"chemical contraction" involved in the passage from $2CO+O_2$ (3 vols.) to $2CO_2$ (2 vols.) was substantially completed at the instant of maximum pressure, the temperature at that instant would have been of the order of 5000° C. In any case the experiment finally disposes of the supposition that carbon monoxide is inherently a "slow-burning" gas. Moreover, the whole character of the pressure-time curve seems inconsistent with the idea, which has sometimes been put forward, that the maximum pressure attained on explosion is materially affected by the dissociation of carbon dioxide; indeed, there was no sign of any "after burning" or heat evolution after the maximum pressure had been attained.

Concluding Remarks.

The energy of a gaseous system such as we have considered is of course comprised partly of translational motions of its molecules as a whole, and partly of motions of some kind internal to these molecules. The former causes pressure (temperature), but the latter (which according to circumstances may be partly rotational and partly vibrational) produces no external physical effect other than radiation, which originates in high-frequency vibrations within the molecule.

Now in each of our experiments a definite amount of energy (thermally equivalent to about 10 K.C.U.) was liberated by the union of carbon monoxide and oxygen in the bomb. Presumably the greater part of this would appear as increased kinetic energy of the products as a whole (*i.e.* as pressure). The lesser part of the energy liberated in such explosions would manifest itself as "radiation" of wave-lengths characteristic of burning carbon monoxide; *i.e.* of incipiently forming carbon dioxide molecules in a highly vibrating state such as would result from CO and : O collisions. Now when nitrogen is present as a diluent it is able to intercept part of the "radiation" whereby it acquires energy of a vibrational kind, which may be intense enough even to dissociate the two atoms of its molecule, or in any case to "activate" it chemically. Such an absorption of radiant energy presumably would not affect the ratios P_m/P_i, except in so far as any part of the nitrogen primarily "activated" successfully competed with the burning carbon monoxide for the available oxygen, and thus became oxidised to nitric oxide during the combustion period. Indeed further experiments (now proceeding) have shown that such nitrogen "activation" is materially influenced by the initial pressure at which the explosive mixtures are fired; but this is an aspect of the matter which time does not permit me to develop.

There is of course nothing new in the idea of an "active" form of nitrogen, for ten years ago the Hon. R. J. Strutt (now Lord Rayleigh) discoursed upon it, and showed how ordinary nitrogen is chemically "activated" when subjected at low pressures to a Leyden jar discharge, whereby it glows and acquires the power of combining with various substances towards which it is normally inert. Such "active" nitrogen was found to be strongly endothermic, and Strutt favoured the view that it consists of dissociated nitrogen atoms, and recombination to form ordinary nitrogen caused the characteristic afterglow.[4]

Another view of the "activation" of nitrogen has been suggested which does not necessitate the complete dissociation of nitrogen molecules. According to Langmuir's statical representation of atomic constitution, there is a great similarity between the configuration of carbon monoxide and nitrogen molecules in the ordinary state, a circumstance to which he has directed special attention. He considers that both molecules are capable of existing in two forms, in one of which (the ordinary and more inert form) the two positive nuclei are both symmetrically located within one and the same outermost shell of eight electrons, whereas in the "active" form they are situated each within one of two separate shells, which have four electrons in common. According to this view not only would the "activation" of each gas be brought about by a reversible transformation from the one configuration into the other, as is shown in Fig. 6, but also an inert nitrogen configuration should be capable of being activated through resonance with a carbon monoxide molecule of similar configuration undergoing combustion.[5]

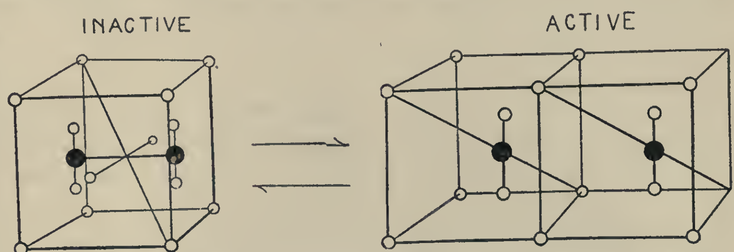


FIG. 6.—Models illustrating the reversible transformation of active nitrogen or carbon monoxide into the inactive form.

It is interesting now to recall the following passage from one of Faraday's letters to Schönbein, which was quoted by the present Lord Rayleigh, when lecturing on "Active Nitrogen" ten years ago. "What of nitrogen? Is not its apparent quiet simplicity of action all a sham? Not a sham, indeed, but still not the only state in which it can exist. If the compounds which a body can form show something of the state and powers it may have when isolated, then what should nitrogen be in its separate state?" Perhaps the behaviour of nitrogen in our high-pressure carbon monoxide-air explosions will help in realising more fully the deep significance of Faraday's words.

In the earlier part of my discourse I directed attention to the peculiar influence of a small addition of hydrogen to a carbon monoxide-air mixture undergoing combustion whether at atmospheric pressure or when exploded at high pressures in the bomb. We have also found that a similar small addition of hydrogen to a normal carbon monoxide-air mixture

[4] Proc. Roy. Inst., vol. xx. part 3 (1914), pp. 656-61.

[5] It may be noted that support is given to the idea of a similarity between the electronic configurations of nitrogen and carbon monoxide, and their capability of acting in resonance during explosions at high pressures, by a paper appearing in the Proceedings of the Physico-Mathematical Society of Japan for April last (*vide* NATURE, June 23, p. 859). For if the electronic configurations of the two gases are similar, their band spectra should be in close agreement; and this is shown to be the case. The author, however, remarks that the specific heat ratios of the two gases are incompatible with Langmuir's assumption of the two nuclei being in the same cube; and he suggests an alternative model, in which two cubes are joined at an edge.

undergoing combustion at high pressures is prejudicial to the "activation" of nitrogen. This is a point of considerable theoretical as well as practical interest; and it harmonises with the views which I have put forward respecting the mechanism of carbon monoxide combustion.

Leaving the many theoretical issues raised by our experiments to be settled by a further appeal to facts as the investigation proceeds, I perhaps may be permitted to indicate in conclusion one or two directions in which, if followed up with adequate means and resources, the work might lead to results of further interest.

In the first place, we have already in some of our experiments attained extraordinarily high temperatures; and we could go even higher were it not for the fact that we are approaching the safety limits of the bomb. If funds were forthcoming for the construction of a new bomb, with the necessary accessories, to enable us to work at still higher initial pressures than we have hitherto employed, we should be able to study the effects of subjecting small quantities of diluent gases to the combined influence of exceedingly high temperatures and intensive radiation. This is an aspect of the research which we are hoping it may be possible for us to pursue in the interests of science.

It is also obvious that our results may have considerable bearing upon the problem of nitrogen fixation. For, having proved that nitrogen can be activated by the combustion of carbon monoxide at high pressures, especially when hydrogen is so far as possible excluded from the system, we have in blast-furnace gas an almost unlimited supply of just the right kind of raw material from which nitric acid could undoubtedly be easily produced under the conditions indicated by our experiment. In view of the national importance of nitrogen fixation we hope these possibilities will be thoroughly explored at home, and not left entirely to foreign organisations, which will probably not be slow to seize upon them. High-pressure combustion work is opening up new possibilities of extending our knowledge, and however much chemical research may have taught us concerning flame and combustion since the time of Davy, there remains a vast amount still to be learned.

Current Topics and Events.

THE terrible calamity in Japan caused by an earthquake on Saturday last, September 1, arouses the most profound sympathy in the scientific world, in which every one has the highest regard for the brilliant achievements of the Japanese. It is reported that the cities of Yokohama and Tokyo, including the Imperial University buildings, have practically been destroyed and that as many as 300,000 persons have lost their lives. The catastrophe is therefore one of the greatest ever recorded, and Japan will need all the help which other nations can give in order to recover from it. The chief shocks occurred about noon on Saturday and were recorded at 4h. 11m. 18s. on Saturday morning on Mr. J. J. Shaw's seismograph at West Bromwich, Birmingham, as well as at other seismological stations throughout the world. The earthquake was preceded by a typhoon; and it will be remembered that the Messina–Reggio earthquake at the end of 1908, when 77,000 lives were lost, was similarly preceded by torrential rain. It is reported that the Osaka Observatory places the seismic centre in the Izu Peninsula. When, in 1906, an earthquake wrecked a great part of the city of San Francisco, the terrible fire which broke out immediately afterwards completed the destruction, and this appears to have been the course of events at Tokyo and Yokohama. As is usual, high sea-waves, often incorrectly called "tidal waves," have flooded low-lying land and thereby added to the destruction and casualties. Most Japanese earthquakes originate in the great trough of the ocean floor, nearly $5\frac{1}{2}$ miles deep, known as the Tuscarora Deep, between the Kurile Islands and the coast of Japan. This was the place of origin in 1896 when the coast of Japan was devastated by three great waves, the largest about 50 feet in height, which caused the destruction of 20,000 lives in a few minutes. The Messina–Reggio earthquake similarly originated beneath the sea and a destructive sea-wave rose to a height of 25 feet and swept over the coasts on both sides of Messina Strait. Japan has suffered grievously from earthquakes and effects caused by them, but the catastrophe of Saturday last seems to have been the worst that it has experienced, and the Japanese people will need great fortitude in order to face the future with the confidence in which they have met other trials in the past.

SIR ARTHUR EVANS has published in the *Times* of August 28 and 29 an account of his past season's excavations at Knossos, which have produced some remarkable results. In particular, a wonderful series of frescoes was recovered from a town house, belonging to the beginning of the Late Minoan age, which was found at a depth of about five metres in an unexcavated strip of ground running up almost to the western border of the Palace. The frescoes had been torn from the walls of upper rooms in the house and lay heaped together in a very fragile state. The principal elements of three or four whole scenes, besides a multitude of detailed features, have been reconstituted. Taken as a whole they are said to afford a unique illustration of the painter's art of the golden age of Minoan Crete at approximately 1600 B.C. The variety of naturalistic detail, which is described as going beyond anything yet brought to light among Minoan remains, includes marine growths, birds, and many flowering plants, some of which can be identified. Monkeys of the genus Cercopithecus, which are not found nearer than the Sudan, and a group of three warriors, of which two are negro mercenaries, point to close African connexions. Some of the painted fragments are partly filled with Minoan writing. The abutment on the Palace of the important prehistoric main road from the south has been established, and Sir Arthur Evans

has found traces of it extending to Phaestos and thence to the havens of the African Sea. It thus brought Knossos into direct connexion with the Nile valley, and explains the intimate relations with Egypt, going back to the earliest dynastic age and beyond, which are recorded in the series of Egyptian relics found in the excavations on this site.

A GALE of unusual severity for the time of year was experienced over England during the latter part of Wednesday, August 29, and the early part of Thursday, August 30. At places in the south-west of England and at Scilly, the strength of the storm reached the force of a "whole gale," the anemometers registering a velocity of 60 miles an hour, while elsewhere on the south and east coasts and in the central parts of England the force of a "strong gale" was experienced, the anemometers registering a velocity of 50 miles an hour. The intensity of the gale was very prolonged, the greatest strength of the storm continuing in many places for six or eight hours. On Tuesday evening, August 28, the centre of the storm was located about 500 miles west-south-west of Ireland and was approaching the British Isles at the rate of thirty-five miles an hour. The centre of the storm passed over Ross-on-Wye on Wednesday evening, when the barometer read 29·17 in., and it continued in a north-easterly track across England, reaching southern Norway by Thursday evening. A noteworthy feature of the storm was the rapid movement or progress of the storm area, which maintained a rate of thirty-five miles an hour for a distance of about 1500 miles from the Atlantic to the North Sea. Heavy rain accompanied the storm, falling most in the advance segment; the amount measured exceeded an inch in the south of Ireland, and at places on the south-west and west coasts of England. Little rain fell in the rear of the disturbance, the weather rapidly clearing as the barometer rose, and brilliant sunshine was fairly general, ten to eleven hours being registered on Thursday, August 30, over England, except in the north and north-west.

THE sixty-eighth annual international exhibition of the Royal Photographic Society will be opened at 35 Russell Square, on Saturday, September 15, at 3 P.M., by the Rt. Hon. Lord Riddell. The exhibition will be open free to the public on September 17-October 27.

WE much regret to announce the death, at fifty-four years of age, of Sir Henry Hayden, F.R.S., formerly director of the Geological Survey of India, in an accident while descending the Finsteraarhorn on August 13; also of Mr. E. K. Muspratt, vice-chairman of the United Alkali Company, president of the Society of Chemical Industry in 1885 and member of the council of the University of Liverpool, on September 1, aged eighty-nine.

THE London Press recently reported the fall of a meteorite during a storm at Immingham, in North Lincolnshire, and stated that it had been secured by the Vicar. The matter has been investigated by Mr. T. Sheppard, of the Municipal Museum, Hull, who finds that the alleged meteorite is a piece of slag from the local ironworks, though it certainly appears to have been fused by having been struck by lightning, which will account for an eye-witness's statement that it made a hissing noise in the water and that steam rose from it.

UNDER the auspices of the National Union of Scientific Workers a meeting is to be held in the Hartley Botanical Laboratories, University of Liverpool, on Friday, September 14, at 5.30 P.M., to which all members of the British Association are invited. A discussion on the relation of "Science and Industry" will be opened by Prof. J. M. Thompson: Mr. J. Sandeman Allen, chairman of the Liverpool Chamber of Commerce, is to preside. It is hoped that a large attendance of local business men will be secured, in order that their interest in the application of science and the claims of men of science for their sympathetic interest and support may be further stimulated.

THE Vancouver correspondent of the *Times* states that a member of the relief party sent in search of the Canadian expedition to Wrangel Island has returned to Nome, Alaska, bringing with him only the Eskimo cook of the party. The expedition, which was under the leadership of Mr. Alan Crawford, was financed by Dr. V. Stefansson, and set out in 1921. The relief party under Mr. Harold Noice found the body of one member of the expedition, who had apparently died of scurvy, and learned that Mr. Crawford with two companions started over the ice for Siberia in December. Nothing has been heard of them since. A bottle was found in Roger Harbour on the south of Wrangel Island containing the names of the party and claiming the island in the name of King George. The relief party left one man with thirteen Eskimos behind to colonise the island and to search for the bodies of the missing men.

IN connexion with the recent correspondence in NATURE on the forms of scientific terms derived from the Greek language, Mr. A. Stanley Pye-Smith sends us a copy of an interesting letter written to "Charles Lyell, jun., Esq., F.R.S." by Dr. J. Pye Smith, F.R.S. in April 1837, and returned by Lyell in 1851 when the biography of his correspondent was being prepared. Dr. Pye Smith protests in this letter against the use of "e" to represent "ai" in Eocene, Miocene, etc., and he points out that this letter leads to obscurity, since it might equally serve as a substitute for "oe," as is the case in the word "economy." He cites several cases in which a diphthong was dispensed with for about a century and was afterwards restored (Cæsar, Phœnicia, ægis, etc.). Curiously enough, he does not criticise the first syllable of Miocene and Pliocene, in which the use of the Greek "ei" has been courageously maintained by Prof. Boyd Dawkins. International usage probably now stands in the way of any changes in either of these well-established terms.

WE have received from Messrs. James Swift and Son, Ltd., 81 Tottenham Court Road, London, W.1, a copy of their "Petro 922" catalogue of petrological

and mineralogical accessories which includes a large variety of micrometers, goniometers, refractometers, spectroscopes and other microscope accessories necessary for routine work or for special research in petrology, mineralogy and crystallography. Among the more important items described are Dr. A. Hutchinson's universal goniometer; the recording micrometer designed by Prof. Shand for geometrical rock analyses; the stage refractometer of Dr. F. E. Wright by means of which the refractive index of a liquid may be easily ascertained, with an accuracy of one or two units in the third place of decimals, on any microscope fitted with a Bertrand lens and a micrometer scale in the ocular; and the tank refractometer designed by Mr. A. F. Hallimond and Dr. H. H. Thomas, which affords a convenient means for determining the refractive indices of liquids in bulk and is useful for expeditiously preparing standard fluids for testing the refractivity of minerals. A price list accompanying the catalogue shows a general reduction in the prices of the apparatus listed.

MR. H. LING ROTH, of the Bankfield Museum, Halifax, has in the press a work on "The Maori Mantle," with numerous illustrations and plates.

THE *Annali di Chimica* is a new journal published at Trieste, devoted to chemical and "astrochemical" matters. The second number, which we have just received, contains articles on the atom, on Sirius and other stars, and on the transmutation of base metals into gold (reprinted from another journal).

ALL who were attracted by the sumptuous art books of Mr. A. Thorburn on "British Birds" and "British Mammals" will be interested to learn that the same author and artist is bringing out through Messrs. Longmans and Co. in the autumn a further work entitled "Game Birds and Wild-fowl of Great Britain and Ireland," with 30 plates in colour showing 58 species. The volume will be issued in two forms, one being on large paper, limited in number to 155 copies.

AMONG the forthcoming books announced by the Cambridge University Press are the following: "Life," by Sir A. E. Shipley, which will form an introduction to biology for the general student; "Physical and Chemical Science," by W. C. D. Whetham; "The Structure of the Atom," by Dr. N. R. Campbell, being supplementary chapter No. 17 to "Modern Electrical Theory"; and a new and revised edition of Prof. G. H. Hardy's "Orders of Infinity: the *Infinitärcalcul* of Paul Du Bois-Reymond," in the Cambridge Tracts in Mathematics and Mathematical Physics.

Our Astronomical Column.

CALENDAR REFORM.—The League of Nations, in addition to the grave political problems which confront it, has found time to appoint a committee to deal with the question of Calendar Reform, more especially as relating to the determination of the date of Easter. The principal religious bodies are represented, the Church of England by Rev. T. E. R. Phillips, secretary of the Royal Astronomical Society. In this connexion an interesting letter, signed "Astronomicus," appeared in the *Times* for August 27. It quoted a resolution adopted by a council representing the Greek and allied churches that was held last May in Constantinople. This extended to ecclesiastical purposes the use of the Gregorian calendar, which had been adopted for civil purposes in Greece some months previously. Thus the Gregorian calendar has now finally superseded the Julian one in Europe, though the process has occupied 340 years.

The resolution also affirmed the willingness of the churches concerned to modify the method of determining Easter, provided it was kept on a Sunday subsequent to the first full moon after the equinox. This condition would be satisfied if Easter were the first Sunday after April 20; this is a later date than most of those suggested, which have been near the middle of the present range, extending from March 22 to April 25.

STELLAR POSITIONS AND THE EINSTEIN LIGHT-BENDING.—The idea has occurred to many people that the Einstein light-bending by gravitation, the existence of which was confirmed at the eclipses of 1919 and 1922, might produce appreciable displacements in the apparent position of stars if their rays passed close to other stars on their way to our system. Signor O. Z. Bianco, of Turin, in a note to us, quotes Bessel's view that the number of dark stars may greatly exceed that of the lucid ones, and infers that serious displacements of the positions of the latter may result. A little consideration will, however, make it plain that the number of cases where the necessary conditions prevail must be extremely small, and even in these cases the proper motions of the three bodies concerned (lucid star, dark star, sun) would quickly modify them, so that the large shift would be of very brief duration.

A ray passing at a distance of one astronomical unit from the sun is deflected through an angle of 0·01″. A study of the stellar masses shows that only a very small minority of the stars have masses greatly in excess of the sun's. Moreover, the majority of the stars are at such distances that an astronomical unit subtends an angle of less than 0·01″. Even if we supposed the dark stars to outnumber the lucid ones a thousand-fold, there would be very few cases of two independent stars approaching each other so closely in direction; but, as a matter of fact, dynamical researches on the stellar motions give no support to the existence of such a large preponderance of dark stars.

It may further be pointed out that shifts of the order of 0·01″ in the positions of stars are quite unimportant, being far below the probable errors of the best catalogues. As an illustration of this it may be mentioned that the correction of meridian observations for the Einstein shift due to the sun has not been suggested by any one, though it would frequently mount to 0·02″. It has already been mentioned in these notes that the Einstein displacement has no effect on the relative positions of binary stars, but only comes into play when one orb is far behind the other. The argument outlined above shows that Signor Bianco's fears are groundless, and that no appreciable errors in star-positions from the cause mentioned are to be apprehended.

Research Items.

EXCAVATIONS AT CIRENCESTER.—Some recent important discoveries at Cirencester are described by Mr. St. Clair Baddeley in vol. xliv., 1922, of the Transactions of the Bristol and Gloucestershire Archæological Society. The remarkable fact results from the excavation of the city wall that portions of it, at any rate, are not of Roman Imperial construction or formed, as has been hitherto accepted, during the late Empire, so as to enclose the then far-expanded, but not yet endangered, Corineum; but that they are of precisely identical character with the dry-walled mounds that encircle many other Cotteswold settlements, made by pre-Roman tribes. In the former case the probability seems to point to the Dobuni, or a previous people, the Cornavii, as the makers of the wall; these mound-enclosures have been in later times occupied in the extension of Roman Cornubium. Mr. Baddeley's paper is illustrated by photographs of the excavations.

TABLET-WEAVING IN ANCIENT EGYPT.—Mrs. Crowfoot and Mr. H. Ling Roth have reprinted a paper from the Annals of Archæology and Anthropology (vol. x., Nos. 1-2), entitled "Were the Ancient Egyptians conversant with Tablet-weaving (Brettchenweberei, Tissage aux Cartons)?" They dispute the theory that tablet-weaving is the origin of all weaving, as has been asserted by Herr H. Pralle. No authentic tablet-weaving tools have yet been found, and the art is not known to be depicted on any wall or other illustration in Egypt. After a careful review of weaving technique, illustrated by numerous drawings, the writers arrive at the conclusion that no tablets have been found earlier than Coptic days, and those of doubtful provenance, and all ancient Egyptian textiles examined by them were certainly not tablet-woven; there is at present no evidence whatever for tablet-weaving in ancient Egypt.

WOOD CARVINGS FROM THE CONGO AND WEST AFRICA.—Mr. H. V. Hall continues in the June issue of the Philadelphia *Museum Journal* his account of a collection of wood carvings from the Congo and West Africa. The article is fully illustrated and describes some remarkable specimens of West African work. The question of foreign influence on this type of native art is not clear, but most of the specimens seem clearly to be indigenous work. The Kroos, at any rate, have been for a long period closely associated with Europeans, and one image seems to represent a Captain Hunt, the master of a steamer, who is seated on a barrel which may have contained nails, or its contents may have been of a liquid nature. The characteristic carelessness of the Negro craftsman in matters of detail is shown by the fact that though the opening of the tight jacket is carefully indicated by a line down the front, yet this is shown folding right over the left, there are no buttons, and no division is marked between jacket and trousers.

APPRECIATION OF TIME.—"An Experimental Study of the Appreciation of Time by Somnambules" is the title of an article by Mr. Sidney E Hooper in the Proceedings of the Society for Psychical Research for July. It is known that some hypnotic subjects display what appears to be a supernormal power of appreciating the passage of time. If, for example, such a subject is told during hypnosis to perform some simple act at the end of 5000 minutes he will do so, at or about the correct time, although in the period intervening between the hypnosis and the performance of the act he has had no conscious knowledge of the suggestion that has been given to him. Experiments demonstrating this peculiarity of the hypnotic state have been recorded by Gurney, Delbœuf, Milne Bramwell, and Mitchell, and Mr. Hooper takes up the inquiry at the point at which it was left by these observers. Two main problems are presented by the results of these experiments: (1) the subliminal calculation by which the subject comes to know the time at which the suggested act is to be performed; (2) "true time-appreciation," by which the subject knows when the time so calculated arrives. When a long time-interval is given in minutes the subject usually calculates subliminally so as to find out when the suggested act falls due. Mr. Hooper's experiments corroborate this; but one of his subjects maintained that as soon as the suggestion was given she began to count rhythmically and continued to do so until the suggested number of minutes had elapsed. It is to such a capacity for accurate counting of seconds by a subconsciousness on which the pendular rhythm of the clock has been faithfully inscribed that Mr. Hooper looks for an explanation of "true time-appreciation."

CALIFORNIAN POLYCHÆTES.—Dr. J. Percy Moore (Proc. Acad. Nat. Sci. Philadelphia, vol. 75, 1923) completes the account of the polychætes dredged off the coast of South California. His three previous papers, published respectively in 1909, 1910, and 1911, dealt with the Nereidiformia, and the present report contains the systematic account of the other suborders. Thirty-three new species are described.

ALPINE WATER-MITES.—Dr. C. Walter's memoir on the Hydracarinæ of alpine waters (Denkschr. Schweiz. Naturforsch. Ges., Bd. 58, 1922), together with previous accounts of Italian investigators of the more southern forms, provides a fairly complete account, at least of the faunistic aspect, of these fresh-water mites. The author has been collecting since 1906, and specimens have been obtained from 433 localities in the basins of the Rhone, Rhine, Danube, and Po. The systematic descriptions are followed by a short comparative account of the eggs and of the larval and nymphal stages. Attention is directed to the great importance of the larval stage in regard to the distribution of many of the species; the larva fixes itself to some insect, inserts its mouth-parts through the skin of its host and so feeds, being meantime transported by the host. The author gives interesting notes on the adaptations met with, *e.g.* the rich development of hairs on the legs of swimming species, the dorso-ventral flattening of the body—and with this a hardening of the dorsal chitin—usual in fluviatile species. The Hydracarinæ of alpine waters may be divided into two groups—the eurythermic species, mostly living in still water, highly adaptive and resistant, and widely distributed; and the stenothermic species, not tolerant of extensive changes of temperature but finding their optimum in water of low temperature, more limited in their range, and found chiefly in the springs and on the shores of high alpine lakes. The author discusses the origin of these two groups—the first largely composed of species which in post-glacial times spread westwards from Central Asia, and the second for the most part a remnant of the glacial fauna. He puts forward anatomical and other evidence indicating the origin of these fresh-water mites from marine mites (Halacaridæ).

NEMATODES OF SHEEP AND CHICKENS.—The two principal communications in the current issue of the *Journal of Helminthology* (vol. i. pt. 3, 1923) are a careful account by T. W. M. Cameron of the anatomy

of *Monodontus trigonocephalus* of sheep, and a description by Dr. R. J. Ortlepp of the life-history of *Syngamus trachealis*, the gape-worm of chickens. The eggs in the uterus of the female Syngamus do not develop there beyond the 16-cell stage, and they are usually laid in this or in the 8-cell stage, and when kept in well aerated water at 25° C. they take about a week to develop into infective larvæ, undergoing one moult during this period. The second stage or infective larvæ are sheathed; they are non-climbers, do not penetrate the skin, and cannot resist desiccation. Larvæ swallowed by chicks reach the lungs in about 24 hours. The path of migration from the digestive tract has not been traced but the author inclines to the view that the larvæ are carried like those of Ascaris and Ancylostoma, *i.e.* in the blood-stream through the heart to the lungs. In the lungs the larvæ grow considerably and undergo two further moults, the final or fourth stage being reached in about five days after infection. The young worms then pair and migrate into the trachea, where, 10 to 14 days later, they attain sexual maturity. Thus the whole life-cycle is completed within a month. Dr. Ortlepp supports the view of Walker and Waite that, in Nature, chickens contract the infection by eating earthworms infected with the larvæ.

A PHYSIOLOGICAL FUNCTION OF THE PITUITARY GLAND.—The chemical constitution of the active substances extracted from the posterior lobe of the pituitary gland is still unknown, but their important pharmacological properties have received much attention and are accurately determined. Until recently, however, the physiological functions of the organ remained a matter for speculation. In a series of researches on pigmentary changes, L. T. Hogben and F. R. Winton have now succeeded in defining such an essential endocrine function in amphibia. They showed (Proc. Roy. Soc., 1922, B, vol. 93, 318-329) that injection of traces of posterior lobe extracts into pale frogs (melanophores contracted) induces profound darkening of the skin (expansion of the melanophores). This action is not elicited by other tissue extracts, whereas the minute posterior lobe of a single frog includes enough active substance to darken at least fifty other pale individuals. So sensitive is the reaction that it may serve as a method of detection or of rough estimation of the potency of such extracts (*Biochem. Journ.*, 1922, vol. 16, 619-630). This response is a direct action on the skin, as can be demonstrated by experiments on the isolated skin, and by the inefficacy of drugs with paralytic action to prevent it. Stimulation of nerve trunks and the administration of the drugs showed no direct evidence of nervous mechanism for pigment control (Proc. Roy. Soc., 1922, B, vol. 94, 151-162). After extirpation of the whole of the pituitary gland the skin always became quite pale and the melanophores completely contracted. This pallor persisted permanently even in the presence of the optimum conditions (cold, wet, and shade) for darkening of normal animals. Injection of posterior lobe extracts was followed by profound darkening with complete melanophore expansion, which lasted for a varying time according to dosage and other conditions, the animals then returning to permanent pallor. Frogs from which anterior lobes only were removed, or with the brains exposed, were indistinguishable from normal animals with respect to their pigmentary reactions. The failure of colour response associated with complete hypophysectomy is therefore due to absence of posterior lobe secretion, and not attributable to anterior lobe deficiency or to the operative technique employed (Proc. Roy. Soc., 1923, B, vol. 95, 15-30).

THE ETHYL ALCOHOL INDUSTRY.—The *Chemical Trade Journal* for August 3 prints a review of the ethyl alcohol industry. The pioneer of synthetic alcohol was Hennell, who, in 1828, found that dilution and distillation of a sulphuric acid solution of ethylene yielded alcohol; this reaction also has considerable theoretical significance. During the War, much alcohol was made from acetylene, which in its turn was produced from synthetic calcium carbide. The acetylene was hydrated directly to acetaldehyde (in the presence of a mercury salt), which was then reduced to alcohol by the Sabatier and Senderens' reaction. Under present economic conditions Germany appears to make most of her alcohol by fermentation methods. The article includes a survey of the physical properties of alcohol, its industrial applications and future prospects for the synthetic product.

CELTIUM OR HAFNIUM?—*Chemistry and Industry* for August 10 contains an important article by Prof. G. Urbain under the title "Should the Element of the Atomic Number 72 be called Celtium or Hafnium?" Prof. Urbain claims that he has had this element in his possession and under his observation since 1911, when he suggested the name celtium for it; that although Moseley in July 1914 (when Urbain visited him in Oxford) was not able to detect the characteristic lines of No. 72 in the fraction submitted for test, two of these lines were, in fact, detected by Dauvillier in 1922, in the spectrum of the same material, by making use of improved experimental methods; that if any doubt existed as to the identity of these lines, it was finally removed by a direct comparison (by the method of coincidences) of lines from the 1911 fraction with a newly-prepared fraction from a zirconium mineral, in which the presence of No. 72 is not now questioned, in view of the *six* characteristic lines recorded by Coster and Hevesy. Under these conditions the claim of the later workers to have discovered a new element (since it could scarcely be based on a more accurate measurement of the same physical property) appears to depend on the assumption that a "fourth group" element *could not have been present* in the rare earth fractions examined twelve years previously by Urbain. Prof. Urbain claims that it was actually there, and that there is no theoretical objection to its presence, since "there is no law which compels the elements to associate themselves strictly in accordance with their classification." Moreover, he had already, in 1921, himself agreed to Perrin's classification of celtium as a fourth-group element, in spite of the fact that he had found it in a rare-earth mixture. He points out that there are many elements with different valencies which cling together so closely that one cannot separate them except by very laborious treatment, and in particular that thorium, which is quadrivalent, is in fact always accompanied by the tervalent rare earths. Again, Bohr's theory only applies to free atoms and simple ions, and affords at present no guidance whatever as to the behaviour of complex ions; it is therefore not able to predict the chemical properties of elements which form double-salts in solution. These give rise, however, to many surprising cases of complete isomorphism, *e.g.* the fluorides of quadrivalent titanium with the oxyfluorides of quinquevalent niobium. Prof. Urbain claims that "no purely theoretical reasoning ought to prevail against a well-established question of fact," and that as regards the presence of celtium in his rare-earth fractions, the facts are not only well established but also in strict accord with general chemical experience.

The Gaseous Nebulæ.[1]

By J. H. Reynolds.

It has been recognised for many years that the nebulæ fall into two great divisions—the spirals and the gaseous and diffuse. The distinction between the two is fundamental, for there can be no doubt now that the spirals are extra-galactic, and the gaseous inter-galactic formations, although it is impossible yet to define the scale and distances of the spirals with any certainty. Since Huggins's great discovery of the gaseous nature of certain nebulæ, the principal work on these objects has been done in America, especially at the Lick Observatory and at Mt. Wilson; and coupling up these investigations with recent advances in physics in which Great Britain has played no mean part, we are able to form a good general idea of the meaning and origin of the gaseous nebulæ.

The first important fact which emerges from the physical work of Fowler, Saha and others, is that only the elements of simplest constitution, such as hydrogen and helium, are known to be present, and that ionisation of known elements is probably responsible for all the unknown lines in the nebular spectrum. Then, again, the gaseous nebulæ are only associated with stars of the highest temperature, as the stars in the centre of the planetaries are usually "O" type stars of the Harvard scale, which yield an emission or absorption spectrum of ionised helium on a continuous background, and the "B" type stars, which are next in order of temperature, and are associated with the irregular gaseous nebulæ in Orion. Until recently it was supposed that the so-called "nebulium" identified with the nebular radiations at λλ5007 and 4959, and other well-known lines such as λλ4363, 4686 and 3727, represented unknown gases in the same sense that helium was unknown until identified in the laboratory by Sir William Ramsay, but the work of Moseley and Aston and the formation of the scale of atomic numbers has taught us that there is no room for any more unknown elements in the atomic scale of the lighter gases, and we must look in the direction of ionisation of the known elements in the first ten numbers of the scale for these unknown nebular lines.

These considerations and the progressive spectra of Novæ lead to the conclusion that in all gaseous nebulæ we are dealing with the same material, and that the differences found in the spectra are to be assigned to differences only in physical conditions, and the key to these conditions is to be found in the effective radiation of the star or stars involved in the nebula. Only the first two numbers of the atomic scale are definitely established as appearing in nebular spectra, the helium appearing often near the nuclear star in its ionised form. But Wright in Lick Observatory Pub., vol. xiii., provisionally identified certain nebular lines with carbon and nitrogen, and the presence of the former at any rate is now accepted.

The principal nebular lines of unknown origin are the following:

$$\left.\begin{matrix}\lambda 5007\\ \lambda 4959\end{matrix}\right\}\lambda\lambda 4363,\ 4340,\ 3868,\ 3727\text{–}9.$$

The first two are invariably found in all the gaseous nebulæ in the same relative strength, and they evidently form a doublet. λ5007 was the first gaseous radiation to be discovered in a nebula, and with its companion it exists in a very marked form in nearly all the objects of this class yet observed. The other radiations vary much in relative strength, and sometimes seem to be absent altogether. Perhaps the most remarkable is that usually described as λ3727, which has been found by Wright to be in reality a doublet separated by only two Ångström units. It is astonishingly brilliant in the Orion Nebula, and with the hydrogen radiations it is responsible for the great photographic effect of this object. It is always of maximum extension, and is found in regions far removed from the involved stars, where the hydrogen radiations are comparatively faint. An investigation by means of screened direct photographs was undertaken by the writer some years ago as to the relative distribution of the doublet λ(5007, 4959), the hydrogen series, and λ3727 in the Orion Nebula. The principal results were:

(1) To establish Keeler's conclusion that the doublet λ(5007, 4959) was conspicuous only in the central region surrounding θ Orionis, where it was very brilliant.

(2) To demonstrate that the hydrogen radiations extended faintly to the most remote regions of the nebula, and

(3) To show that the radiation λ3727 was much stronger than the hydrogen in these outer regions, besides giving certain differences in detail.

We have then in the Orion Nebula a bright central portion where the radiations λ(5007, 4959), the hydrogen and helium radiations and λ3727 are integrated together, an intermediate region where hydrogen and λ3727 appear of about the same strength, and an outer region where λ3727 predominates. There is no difficulty in ascribing λ(5007, 4959) probably to an ionised form of one of the elements heavier than helium, as we should expect the heavier elements to predominate in the central regions surrounding the star θ and the other involved stars. There is, however, very great difficulty in explaining the distribution of λ3727. It must be remembered that the "B" type stars involved in the nebula are not of the highest stellar temperature, and it is almost impossible to imagine the existence of ionisation at all in these remote regions. There is, indeed, good reason for thinking that λ3727 is a comparatively low temperature radiation, as it is either faint or absent altogether in the planetaries containing "O" type stars, and it does not occur so far as can be ascertained in the nebular stages of Novæ.

An interesting point bearing on the distribution of this radiation is brought out by an examination of the nebulosity surrounding the star Bond 734 to the north of the principal nebula. In the screened exposure of the radiations λ(5007, 4959) no nebulosity appears round this star, and the absence of these radiations is confirmed in Lick Observatory Pub., vol. xiii. The hydrogen image is quite strong, and is accompanied by an equally strong image in λ3727. It is quite evident, therefore, that there is no direct relation between the radiations λ(5007, 4959) and λ3727, and it is known that the hydrogen radiations occur without either. But the question arises as to whether λ3727 can exist independently of hydrogen. The differences of detail visible in the photographic images given by hydrogen and λ3727 certainly suggest an independent origin, but a complete answer to the question is impossible, as hydrogen is found in varying strength in all the gaseous nebulæ and novæ. If it were not an impossibility, one would naturally look for the radiation as some element actually lighter

[1] Substance of an address delivered before the Birmingham University Physical Society on March 14, 1923.

than hydrogen. The origin of this radiation λ3727, therefore, seems to be one of the most interesting and difficult problems which the astrophysicist has to deal with at the present time.

We will now pass on from the Orion Nebula, which may be taken as a good example of the irregular gaseous nebulæ connected with "B" type stars, to the planetaries. Here we have to deal with involved central stars which are of the "O" type, of a considerably higher temperature. In the spectra of these nebulæ the doublet λ(5007, 4959) is still usually the strongest radiation, and hydrogen is invariably present. On the other hand, λ3727 is often comparatively faint or absent altogether, although λ3869 is still one of the strongest radiations in the spectrum. Ionised helium at λ4686 is also very conspicuous, but does not extend far from the nucleus, showing that ionisation only takes place in the neighbourhood of the star itself. Another bright radiation at λ3426, found in the spectrum of Nova Cygni III, also makes its appearance, but its extension from the nucleus is small.

A very remarkable feature in the high dispersion spectra obtained with the three-prism spectrograph of the Lick 36-in. refractor was the character of the lines under magnification. When the slit of the spectrograph was placed across the major diameter of the planetary nebula disc, the resulting lines in the doublet λ(5007, 4959) were not parallel-sided, but spread out in the centre, each end being slightly curved in opposite directions. If we are to interpret this phenomenon on the Döppler principle in the usual way, this means that the gases are both receding from us and advancing towards us in the line of sight, coupled with a slight rotation of the gaseous spheroid as a whole. The only feasible explanation is that the gaseous shells forming the nebula are still expanding, and we are at once led to a comparison with novæ such as Nova Aquilæ III, which now has developed an expanding gaseous disc.

The later spectroscopic stages of novæ are comparable in every detail with the planetary nebulæ; the galactic distribution of both is similar, and the evidence is now overwhelming that the planetaries had their origin in novæ, and the gaseous shells of the planetaries are the remains of past outbursts. It may be asked why the planetary nebulæ are comparatively few in number, but it is evident that if the central star fell to a lower temperature than the "B" type, the radiation would be insufficient either to keep the gases in a state of equilibrium or to illuminate them, and the aspect of a planetary nebula would disappear. The same remarks apply to objects like the Orion Nebula connected with "B" type stars. Here the radiation energy is not so intense as the "O" stars, and we do not get an equal degree of ionisation: the strength of the radiation λ3727 is also evidence of different physical conditions, but the Orion and other irregular gaseous nebulæ have every appearance of being swept away from the involved stars, and they all probably indicate a former outburst of several stars culminating in an "O" type of spectrum and a high radiation pressure.

The old idea that the gaseous nebulæ were the primitive forms of matter from which stars were evolved must, it seems, be given up for the exactly contrary hypothesis that they had their origin in stellar outbursts, where matter passed from complex to simpler forms by atomic disintegration under the stress of extreme temperature development.

Plants in Relation to the Health of Man.[1]

CINCHONA, the plant which yields quinine, known under the name of "Jesuits' Powder" since 1655, was introduced into India about the years 1858 to 1862. Seedlings and seeds were brought to Great Britain from the Andes of Bolivia during those years, principally by Sir Clements Markham and Mr. Richard Spruce, and the plants, which were raised at the Royal Botanic Gardens, Kew, were taken to India and Ceylon. The cultivation in India was mainly established in the Nilgiri Hills and in Sikkim. The three species of Cinchona which are particularly valuable as sources of quinine are *C. Calisaya*, *C. Ledgeriana*, and *C. succirubra*.

The Dutch had also been experimenting with Cinchona and established the plant in Java about the same time as the English were introducing it to India. So successful have the plantations been in India, thanks to the labours of Dr. Thomas Anderson, Sir George King, Messrs. Wood and Gammie and Sir David Prain, that in every post office in India it is now possible to procure doses of from seven to ten grains of pure quinine for a *pice*, which is about equal to a farthing. In this way, more than eight thousand pounds avoirdupois of quinine are distributed yearly, and in addition to this a large supply is furnished to hospitals, etc. Efforts are now being made to extend the cultivation of quinine in Malaya and Burma. Substitutes for Cinchona as a source of quinine were used in the Cameroons by the Germans during the War.

Other interesting plants are Efwatakala grass, *Melinis minutiflora*, which is reported to be obnoxious to the tsetse fly; citronella grass, the source of lemon grass oil, which is repellent to mosquitoes; and *Ocimum viride*, the Basil plant, which at one time was thought to be repellent to mosquitoes, but now is known to be of no value for the purpose.

In connexion with the preservation of the health of man in temperate climates, the plants yielding india-rubber are of first importance. The principal source of india-rubber is *Hevea brasiliensis* (Para rubber). This again is a native of South America. Seeds and young plants have been distributed to the various tropical colonies of the British Empire since the year 1873, when it was brought over from South America, mainly owing to the successful efforts of Sir Henry Wickham. Other sources of rubber are the Ceara rubber, *Ficus elastica*, Funtumia, and the tropical African Landolphias. The rubber now used commercially is mainly derived from plantations in the East, to which region it was introduced through the Royal Botanic Gardens, Kew.

Another source of protection against damp and cold is furnished by the various plants which yield tannin, the preservative of leather. The principal sources of this are oak galls and bark, mangrove bark, Myrobalans, Quebracho, and *Acacia decurrens*. Extensive plantations of the latter plant, which is a native of Australia, have been made in South Africa and are a source of considerable wealth to Natal.

Cinnamomum Camphora, which is a native of Formosa, is the source of camphor, valuable as a drug and also a preservative of clothing against moth. Trade in camphor is a monopoly of the Japanese, but seeds have been freely introduced to British colonies, largely through the agency of Kew. It is now found there are two forms of camphor, but only one of these yields the solid camphor which is of value.

Erythroxylon Coca is the source of cocaine, the alkaloid which has so many useful as well as harmful effects.

[1] From a Chadwick public lecture delivered by Dr. A. W. Hill, F.R.S., at the Chelsea Physic Garden, on June 13.

The Liverpool Meeting of the British Association.

THE following Dominion and foreign representatives are expected to be present at the Liverpool meeting of the British Association which begins on Wednesday next, September 12. In the programmes of the various Sections, published in last week's issue, announcement was made of papers to be read by these visitors and of discussions in which they will take part.

Prof. F. D. Adams, McGill University, Montreal.
Prof. W. D. Bancroft, Cornell University, Ithaca.
Prof. N. Bohr, Institut for Teoretisk Fysik, Copenhagen.
Mr. S. C. Brooks, Hygienic Laboratory, Washington.
Dr. Herbert Bruce, University of Toronto.
Prof. A. H. R. Buller, University of Manitoba, Winnipeg.
Senatore Principe G. Conti, Florence.
Dr. D. Coster, Copenhagen.
Prof. P. Ehrenfest, University of Leyden.
Prof. E. Ekwall, University of Lund.
Prof. A. S. Eve, McGill University, Montreal.
Dr. K. G. Falk, New York.
Prof. J. C. Fields, University of Toronto.
Prof. V. M. Goldschmidt, Universitetets Mineralogisk Institut, Kristiania.
Prof. V. E. Henderson, University of Toronto.
Dr. G. Hevesy, Copenhagen.
Prof. D. R. Hoagland, University of California.
Prof. O. Jespersen, Copenhagen.
Prof. A. E. Kennelly, Massachusetts Institute of Technology, Cambridge, Mass.
Dr. P. L. Kramp, Zoological Museum, Copenhagen.
Dr. A. C. Kruyt, University of Utrecht.
Prof. P. Langevin, Collège de France, Paris.
Dr. V. Lebfelter, Folksgesundheitamt, Vienna.
Prof. F. S. Lee, Columbia University, New York.
Prof. G. N. Lewis, University of California.
Prof. A. B. Macallum, McGill University, Montreal.
Prof. J. C. McLennan, University of Toronto.
Prof. J. J. R. Macleod, University of Toronto.
Prof. R. Magnus, University of Utrecht.
Prof. A. P. Mathews, University of Cincinnati.
Prof. E. Merritt, Cornell University, Ithaca, New York.
Prof. A. R. Moore, Rutgers College, New Brunswick, N.J.
Dr. Th. Mortensen, Universitetets Zoologiska Museum, Copenhagen.
Prof. W. A. Noyes, University of Illinois.
Prof. Sven Oden, Kgl. Tekniska Hogskolan, Stockholm.
Prof. W. A. Parkes, University of Toronto.
Prof. M. I. Pupin, Columbia University, New York.
Prof. H. M. Quanjer, Institut voor Phytopathologie, Wageningen, Holland.
Prof. Roule, Musée d'Histoire Naturelle, Paris.
Prof. R. L. Sackett, State College, Pennsylvania.
Prof. J. Satterly, University of Toronto.
Dr. Johs. Schmidt, Carlsberg Laboratorium, Copenhagen.
Prof. J. Sebelien, Aas, Norway.
Prof. H. B. Speakman, University of Toronto.
Dr. V. Stefansson, Canada.
Prof. J. Tate, McGill University, Montreal.
Prof. W. Vernadsky, Paris.
Senatore Prof. V. Volterra, University of Rome.
Dr. G. S. Whitby, McGill University, Montreal.
Prof. A. Willey, McGill University, Montreal.
Prof. R. W. Wood, Johns Hopkins University, Baltimore.
Prof. H. Zwaardemaker, Universitas Rheno-Traiectina, Utrecht.

Relativity and Theory of Knowledge.

THE *Scandinavian Scientific Review*[1]—a new quarterly in English published in Norway—contains in its first number an original and important piece of philosophical research in an article entitled "The Theory of Relativity and its Bearing upon Epistemology," by Prof. Harald K. Schjelderup, the recently appointed professor of philosophy in the University of Christiania. The author is already distinguished in his own country, although he is probably the youngest occupant of a chair of philosophy, having been born in 1895.

The article begins with a lucid exposition of the principle of relativity which calls for no special remark, but it proceeds to examine the consequence of its acceptance in physics for theory of knowledge. It is obvious that it must make a clean sweep of all naïvely realistic theories, materialistic or spiritualistic, which assume the physical reality of the universe to be presented objectively to the mind of the observer for his discernment by means of sense discrimination. But does it accord with idealism? Does it deny that there is any objective universe to which knowledge can attain? Does it require us to be content with the subjective space-time universes of individual observers? Prof. Schjelderup answers emphatically, No. Relativity gives us not a relative but an absolute universe, a universe the scientific reality of which, however, is completely different in its nature from anything which men of science have hitherto imagined or thought it necessary to assume. The Minkowski four-dimensional space-time universe is absolute, in precisely the same sense in which Newton's three-dimensional space and independent variable time were absolute, and the world-lines of the Minkowski universe with their intersecting points determined by Gaussian co-ordinates are real in the objective sense, but the reality is not sense-presented, it is unimaginable and imperceptible. It consists, like the reality of Pythagoras, of numbers.

The point of special interest in the argument is the way in which the author brings out the deciding influence in physical theory which the epistemological weakness of the older mechanics has had. It was Galileo, the founder of modern physics, who, in his discrimination between what he called the accidental and the essential attributes of things, first suggested the distinction between secondary and primary qualities, which has played a determining part in later theories of knowledge. Galileo found his interpreter in Descartes, who reduced physical reality to extension and movement. The principle of relativity has eliminated even the primary qualities from the subject-matter of physics.

Similarly in the relation of Kant to Newton, we see the directive force of the epistemological weakness of a physical theory. The subjectivity of time and space in the Kantian theory meant their transcendental ideality. Abstracted from the subjective conditions of sensory observation they are invalid. But relativity goes further, it eliminates time and space not only from an unknowable thing-in-itself, but even from the subject-matter of physics. To us to-day the principle of relativity is not a return to older philosophical concepts, but a forward movement looking for a new philosopher to interpret a new epistemology.

[1] *Scandinavian Scientific Review*: Contributions to Philosophy, Psychology and the Science of Education by Northern Scientists. Vol. I., No. 1, September. Pp. 136. (Kristiania: Scandinavian Scientific Press A/S, 1922).

Pan-Pacific Science Congress, Australia, 1923.

WHILE not on so extensive a scale as, nor with the Imperial significance of, the Australian meeting in 1914 of the British Association for the Advancement of Science, the second triennial Pan-Pacific Science Congress, which has just met in Melbourne and afterwards in Sydney, may mean very much to the development of organised knowledge of, and in, countries bordering upon the Pacific Ocean. The first gathering of the kind was held in Honolulu in 1920, and as a matter of fact it was really the sequel to ideas that originated during the British Association visit to Australia and later were warmly fostered by Prof. W. M. Davis (Harvard), Prof. H. E. Gregory (Yale), Dr. T. Wayland Vaughan (U.S. Geological Survey), Mr. A. H. Ford, and others. The Pan-Pacific Union, a wide organisation with the general aim of promoting harmonious relations between the peoples of the Pacific, stood behind the Honolulu Congress, but future Science Congresses will undoubtedly all be under the general direction and control of the National Research Councils of the countries concerned.

The Commonwealth Government is acting as host for the 1923 gathering, the organisation being in the hands of the Australian National Research Council, of which Sir David Orme Masson is president. State Governments are generously supplementing the Commonwealth's financial and other assistance, and it has been possible in many cases to make grants helping to defray travelling costs for delegates from distant countries. The prevailing high rates for steamship travelling are a grave difficulty in the way of international assemblies in a region of such vast distances as the Pacific. Happily the interest of the Governments of the chief countries concerned has been aroused, and invitations, conveyed through the Colonial Office, to send official delegates, have met with much response. Unfortunately the South American Republics, with few exceptions, have regretted that their financial conditions do not permit the sending of official representatives. Even more unfortunate is it that France has not seen fit to send a delegation. Nevertheless, with eleven visitors from Great Britain, nineteen from the United States of America, three from Canada, eight from Hawaii, twelve from Japan and Formosa, nine from the Philippines, six from the Netherlands and the Dutch East Indies, eleven from New Zealand, and smaller delegations from British Malaya, Burma, Tahiti, Papua, Fiji, and Hong Kong, a very fairly representative gathering is assured. While in Australia, all visitors from overseas are the guests of private citizens or institutions and are receiving the privilege of free railway travelling before, during, and after the Congress.

To transfer a congress after ten days in one city to another some six hundred miles distant must militate against consecutive work and lead to a certain amount of overlapping; but the advantages in enabling visitors to see more of the country, and in increasing the numbers of local workers who come into personal contact with them, more than counterbalance the obvious disadvantages.

Needless to say, an extensive series of excursions has been arranged, the principal excursions, over long distances, necessarily coming after the official business in Sydney has been concluded. Visits to Broken Hill, Irrigation Areas, Artesian Water Areas, Great Barrier Reef, Northern Rivers to Brisbane, Canberra and other parts of the Commonwealth, are proposed.

The scientific work is being carried on in eleven Sections. As, however, it has been a deliberate object of the organisers to avoid a multiplicity of papers on single and more or less isolated topics, and to aim instead at broad general discussions, there are several joint meetings between Sections. The Sections comprise: I. Agriculture; II. Anthropology and Ethnology; III. Botany; IV. Entomology; V. Forestry; VI. Geodesy, Geophysics, Radiotelegraphy, etc.; VII. Geography and Oceanography; VIII. Geology; IX. Hygiene; X. Veterinary Science; and XI. Zoology.

The agriculturists are concerned chiefly with the problems presented by diseases in wheat and other cereals, sugar-cane, cotton, tobacco, bananas, etc., and on the serious difficulties to be faced in controlling weed pests. Proposals for plant quarantine regulations may represent an immediate practical outcome. Agricultural education and research, soil surveys, and irrigation questions are also being discussed, while much interest is being taken in a joint discussion with the zoologists and veterinarians upon genetics, with special reference to the improvement of farm animals.

In anthropology and ethnology the Congress is attacking the fundamental problem of how best to organise and carry out research work in the Pacific Islands before it is too late. The matter is very urgent indeed. Expressions of opinion have been invited from leading ethnologists in Great Britain who cannot be present in person, and it is hoped that, so far at least as the British islands are concerned, a practical working scheme may be evolved, to be submitted later, with the full weight of the Congress behind it, to the Commonwealth Government. Sir Baldwin Spencer, who has just returned from yet another visit to the interior, is bringing forward the allied, yet distinct, question of future research in regard to the Australian aborigines. Another wide topic under consideration, in common with the Hygiene Section, is the recent rapid decline in native population in the islands, while there are also discussions upon the physical anthropology of various Pacific types, and the race relations between them.

Botany, entomology, and forestry have much in common in several proposed discussions upon timbers, and with zoology the matter of introduced pests and their natural enemies is being taken up, especially the increasingly serious problem of checking the spread of tropical boring insects.

The physical work of the Congress centres mainly round geodesy, terrestrial magnetism, meteorology, and seismology, while the highly practical international matters of radiotelegraphic communications and determinations of longitude by wireless, are also being discussed. Solar physics research, for which many maintain that more is being claimed on the purely practical side than it will yield, and the need for its endowment by Governments, is a subject for vigorous debate.

Those members concerned with geography and oceanography are meeting with the physicists frequently, especially when discussing questions of cartography and meteorology. Definite proposals are being made for continuing and extending, by local effort, the invaluable hydrographic work of the Royal Navy, and for international collaboration in oceanographic work.

As might be expected, the largest Section is that devoted to Geology. The structure of the Pacific Basin, Post-mesozoic volcanic action in the Pacific, ore provinces, correlation of Kainozoic formations, coral reef formations, glaciation, Carboniferous and Permian problems in the Pacific Region, are among the more general matters before the Section.

Two main subjects discussed in the Hygiene Section,

at Melbourne, are mining hygiene and a general survey of the hygiene of the Pacific Region. The basis for discussion of the latter is a summary of replies received by the director of the Commonwealth Department of Health to a widely circulated *questionnaire* relating to yellow fever, malaria and filariasis, bubonic plague, small-pox, leprosy, beri-beri, hook-worm disease, and tuberculosis. In Sydney, the principal topics are climate in relation to human efficiency, meteorological standards in relation to comfort, and insects in respect to hygiene.

The work of the Veterinary Science Section is mainly in joint meetings with allied Sections, such as Agriculture and Zoology, in dealing with parasitological and other problems. Proposals are being put forward with regard to international notification of animal diseases.

Finally, the Section of Zoology is undertaking, in addition to much conjoint work with other Sections, a general survey of the many questions now arising in connexion with Pacific fisheries and the establishment of marine biological stations.

The main aim of the Congress is to deal with wide subjects, many of them of international significance, from a practical as well as a purely scientific point of view.

A. C. D. Rivett.

University and Educational Intelligence.

We learn from the *Chemiker Zeitung* of the following appointments: Dr. W. Schumann, director of the Institute of Technical Physics at Jena University, to be professor of theoretical electrotechnics at the Munich Technical College; Dr. Julius Schmidt, of the Stuttgart Technical College, to be reader in chemistry at the Engineering College, Esslingen; and Dr. K. Fajans, to be assistant professor of physical chemistry at the University of Munich.

The trustees of the Laura Spelman Rockefeller Memorial, founded in October 1918 by John D. Rockefeller in memory of his wife, have published a report on their appropriations, amounting to nearly 13 million dollars, up to December 31, 1922, on which date the corporation's assets amounted to 78 million dollars. Grants classified under the head "Education" amounted, in the four years 1919–1922, to 6000, 9000, 286,000, and 500,222 dollars respectively, and included 30,000 in 1921 for the American College for Girls at Constantinople, 110,530 dollars in 1922 for Robert College of Constantinople, the American University of Beirut, and the Constantinople Women's College, and 600,000 dollars for the Women's Union Christian Colleges in the Orient. For boy scouts and girl scouts grants amounting to 193,000 dollars were allocated, and an appropriation which will amount to more than 55,000 dollars was made for the inauguration of courses of instruction for scout leaders in universities and women's colleges. Such courses, it is noted, are given in 42 institutions, and in 13 of them the expense of instruction has already been taken over by the college. Scientific research interests the trustees because they "believe that knowledge and understanding of the natural forces that are manifested in the behaviour of people and of things will result concretely in the improvement of conditions of life," but grants for promoting it have hitherto been small: 13,000 dollars in 1921 and 37,500 in 1922, including 10,000 for the Mme. Curie Radium Fund. The Y.M.C.A. and Y.W.C.A. and other social welfare organisations received 3,299,000 dollars; religious organisations, 1,975,000; emergency relief, 1,543,000; and public health, 692,000.

A report on the development of higher education in Poland has been issued by the Chief Statistical Office of the Polish Republic. For the five State universities the report shows the following student enrolments:

	Cracow.	Warsaw.	Lwów.	Poznań.	Wilno.	Total.
1920–21 . .	4136	5787	3639	2094	788	16444
1921–22 . .	4531	7518	4773	3273	1729	21824
1922–23 . .	5235	8939	5646	3416	2202	25438

For the technical State schools the respective numbers are:

	T.H. Sch., Warsaw.	T.H. Sch., Lwów.	Agric. Coll., Warsaw.	Sch. of Min., Cracow.	Total.
1920–21 . .	2931	2178	787	179	6075
1921–22 . .	4112	2305	761	282	7460
1922–23 . .	3868	2560	906	462	7796

The following figures show the number of students admitted in 1922–23 to other higher schools and professional colleges: Independent University, Lublin, 1120; Free Polish University, Warsaw, 1664; College of Commerce and Economics, Warsaw, 988; Veterinary College, Lwów, 327; Teachers' College, Warsaw, 124; School of Fine Arts, Cracow, 155. Of the total number of students, about 24 per cent. were women. Nearly 27 per cent. were enrolled in faculties of jurisprudence, 13 per cent. in faculties of medicine, 17 per cent. were engaged in the study of technology, mechanical and electrical engineering, etc., about 6 per cent. were students of agriculture, and 30 per cent. devoted themselves to the study of philology, history, mathematical and natural science, philosophy, and education.

Lists of colleges and universities "accredited" by various agencies are published in Bulletin, 1922, No. 30, of the United States Bureau of Education. The standardising movement has advanced rapidly during the past ten years, and the lists published in 1917 already need revision. The agencies in question are: certain State universities and departments of education, the Carnegie Foundation for the Advancement of Teaching, the Association of American Universities and several other voluntary educational associations, and church boards of education. The Bureau is careful to announce in large type that "there is no comprehensive classification of collegiate institutions by any national governmental agency." The longest of the lists is that drawn up by the University of California of 286 institutions from which holders of bachelor degrees representing the usual college course of four years will be admitted to its own graduate division. Commenting on the lists, the compiler notes that the standards used are very various and the basis of classification in some cases is very vague, while "there is no practical consensus of opinion as to what constitutes that much-talked-of entity, the standard college." He finds ground for hope of a coming approximation to uniformity in this regard in the fact that a committee appointed for the purpose by the American Council on Education has formulated certain principles and standards for 4-year colleges and universities which have been adopted in whole or in part by some of the accrediting agencies. Among these principles are: "Teaching schedules exceeding 16 hours per week per instructor, or classes (exclusive of lectures) of more than 30 students, should be interpreted as endangering educational efficiency"; and "the minimum annual operating income, exclusive of payment of interest, annuities, etc., should be \$50,000, of which not less than \$25,000 should be derived from stable sources, other than students, preferably from permanent endowments."

Societies and Academies.

PARIS.

Academy of Sciences, August 6.—M. Guillaume Bigourdan in the chair.—A. **Lacroix**: Comparison of the chemical composition of two Iceland lavas, characterising eruptions of which the kind of dynamism is different. Analyses of five lavas and basalts from Katla and Hecla. As regards the distinction between quietly flowing and explosive eruptions, the author holds that the fluidity of the magma is not the only explanation of the different types of eruption, since a fluid magma, which according to Washington, should flow out quietly, if suddenly cooled on its egress into the air, may give rise to an explosive eruption. The eruption of Hecla is an example of this: the fluid lava had to force its way through the ice cap of the Myrdalsjökull glacier and the eruption throughout was of the explosive type.—G. **Bigourdan**: Project of a new catalogue of the French learned societies.—André **Blondel**: A rational method for tests and specification of triode lamps intended to work as valves. An outline of tests to be made partly at the works where the lamp is constructed, and partly at the laboratory where the lamp is to be used.—Charles **Nicolle**, E. **Conseil** and A. **Cuénod**: Preventive vaccination against acute conjunctivitis due to the Weeks bacillus. Its importance in the campaign against trachoma. Details are given of the preparation of the vaccine and of the results of experiments demonstrating the protective action of the vaccination.—Nilos **Sakellariou**: Oblique linear curvature and total geodesic curvature.—F. H. **van den Dungen**: Some technical applications of integral equations.—Rolf **Nevanlinna**: The theorem of M. Picard.—R. **de Fleury**: Elastic stability and modern materials of construction.—A. **Grumbach**: The superposition of electromotive forces in batteries with a fluorescent liquid.—R. **Levaillant**: Fluorescence and photochemistry. A certain number of fluorescent colouring matters (uranine, methylene blue, eosin, erythrosine) dissolved in glycerol or other polyalcohol, when submitted to light in the absence of air change colour, owing to hydrogenation by the alcohol. The original colour is more or less completely restored by the action of air.—G. **Vavon** and S. **Kleiner**: Catalytic hydrogenation and steric hindrance. The study of some heptenes. The addition of hydrogen to four isomeric heptenes (ethylpropylethylene, dimethylisopropylethylene, methyldiethylethylene and trimethylethylethylene) was studied in the presence of platinum black. It was found, in agreement with the theory of steric hindrance, that the hydrogenation was more difficult the greater the number of substituting radicles.—V. **Agafonoff**: The comparative study of some methods of chemical analysis of the humus in soils. A comparison of the amounts of carbon in soil determined by combustion, by the ordinary sulphochromic process, and by Simon's method (with silver bichromate). The dry combustion and Simon's method are in good agreement: the ordinary wet combustion with sulphuric and chromic acids only gives low results.—Pierre **Lesage**: Anomalies of the fruit of *Capsella Bursa-pastoris*, caused by the presence of salt in the soil.—L. **Blaringhem**: The biological control of the influence of manures: determination of the sensible periods.—Robert **Stumper**: The chemical composition of the nests of *Apicotermes occultus*. The nests are made of sand, cemented together with about 15 per cent. of organic secretion.—J. **Benoit**: The origin of the interstitial cells in the testicle of the domestic cock.—Et. **Burnet**: Irregular reactions of the filtrate from broth culture in goats infected with *Micrococcus melitensis*. If the infection by this Micrococcus renders the goat as sensitive as man to the inoculation of a small quantity of filtered culture, this reaction should afford a rapid and certain means of recognising infected goats and preventing the use of their milk. It has been proved, however, that the reaction is very irregular, and some goats, certainly infected, do not show the reaction at all. The conclusion is drawn that the filtrate creation cannot be used in practice as a means of diagnosing *Melitensis* in the goat.

August 13.—M. Guillaume Bigourdan in the chair.—A. **Lacroix**: The signification of the alkaline granites very rich in soda. The study of the rocks collected from the island of Rockhall has shown that rockallite, described as a persodic granite, has no real geological existence. Chemical analyses of various portions of the granite and its enclosures are given.—Torsten **Carleman**: Functions indefinitely derivable.—Jules **Baillaud**: Studies on the distribution of the energy in stellar spectra made at the Pic du Midi Observatory in 1920 and 1921. The spectra of nine stars have been studied. The arrangement of apparatus and method of carrying out the observations are described: the details of the experiments and the results will be published elsewhere.—R. **de Mallemann**: The theory of rotatory polarisation.—J. **Bathellier**: Correction relating to the nests of Eutermes. In a preceding note a series of fungus beds forming part of an ant nest have been described as belonging to *Eutermes matangensis*. It would appear that this view was incorrect: the structures are probably the work of an insect determined by M. Bugnion as *Microtermes incertus*.—E. **Bugnion**: Remarks on the note of M. Bathellier.—O. **Duboscq** and H. **Harant**: Sporozoa of the Tunicates.

Official Publications Received.

Egyptian Government. Almanac for the Year 1923. Pp. viii+256. (Cairo: Government Press.) P.T. 10.

Calendar of State Papers, Colonial Series, America and West Indies, June 1708–1709, preserved in the Public Record Office. Edited by C. Headlam. Pp. xliii+642. (London: H.M.S.O.) 40s. net.

Annual Report of the Meteorological Observatory of the Government-General of Chosen for the Year 1920 (Results of Observations). Pp. iii+141+1 map. (Zinsen.)

Results of the Meteorological Observations in Korea for the Lustrum 1916–1920. Pp. vii+48. (Zinsen).

N.S.W. Department of Mines. Geological Survey. Bulletin No. 8: Copper. By E. J. Kenny. Pp. 51. (Sydney: A. J. Kent.)

Annual Report of the Board of Regents of the Smithsonian Institution for the Year ending June 30, 1921. Pp. xii+638. (Washington: Government Printing Office.)

Smithsonian Institution. U.S. National Museum. Bulletin 120: The Opalinid Ciliate Infusorians. By M. M. Metcalf. Pp. viii+484. (Washington: Government Printing Office.)

Thirty-seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1915–1916. Pp. viii+560. (Washington: Government Printing Office.)

Aeronautics. Report of the Aeronautical Research Committee for the Year 1922–23. Pp. 48. (London: H.M.S.O.) 2s. net.

Fishery Board for Scotland. Salmon Fisheries, 1921, No. IV. Salmon Investigations in Scotland, 1921, IV. Summary of Results (with 7 diagrams). By W. J. M. Menzies, Jun. Pp. 18. (Edinburgh: H.M.S.O.) 1s. 6d. net.

Air Ministry. Meteorological Office. Geophysical Memoirs, No. 21. Pyrheliometer Comparisons at Kew Observatory, Richmond, and their bearing on data published in the *Geophysical Journal*. By R. E. Watson. Pp. 17. (London: H.M.S.O.) 2s. net.

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Science and Publicity.

IN his presidential address to the British Association on Wednesday last, on the electrical structure of matter, Sir Ernest Rutherford dealt with a subject of fundamental scientific importance, as well as of popular interest—possibly on account of the conception of flying atomic projectiles and their disintegrating effects. The Association thus opened its proceedings this year with a discourse which is likely to make a wide appeal. Whether members of the general public who have not themselves made scientific observations or experiments can have an intelligent comprehension of the true inwardness of work and theory on atomic structure, or on many of the other intricate subjects dealt with in presidential addresses and papers presented to the various Sections, may perhaps be doubted; but even if the mental grasp be weak and the picture induced be primitive, the mere existence of a respectful attitude and receptive mind towards scientific studies is not to be despised.

In the main, of course, the Association is an assembly of scientific workers, most of whom have no wish to discourse to the laity and no capacity for transforming the special vocabularies of their subjects into the simpler—not to say sensational—forms required by many general readers. It ought to be gratefully recognised, however, that the lay writer who is sufficiently well informed to be able to present a scientific subject in attractive literary style, and accurately as well, is performing a useful purpose for science. The investigator who can do this for advances to which he has himself contributed, and on which he is an authority, can always find a generous welcome on platform or in the periodical press, but it is rarely that the faculties of research and exposition are so closely combined; and it may be just as well that they are usually separated. The first business of the man of science is to discover—to add to the sum of natural knowledge; and if he describes his work clearly and in terms which are intelligible to other investigators, he has done his part. It is really supererogatory for him to take up the task of enlightening—or entertaining—a public unfamiliar with even the alphabet of the language of the branch of science in which he works. He may be able to interest members of the British Association, because most of them are engaged in scientific work of one kind or another, and the rest scarcely expect to listen to childish discourses; but the crowd in the street is not within his ambit. The active scientific investigator might appropriately apply to those outside his gates the words, "I have yet many things to say unto you, but ye cannot bear them now." Science does not need to be sought with a contrite

heart, but it does demand a certain amount of preparation from all who would understand the full meaning of the treasures within its temples.

So far as it is possible for men of science to offer popular expositions of subjects on which they are creative authorities, this is done in the Citizens Lectures now delivered at each meeting of the British Association and on a more extended scale than usual at this year's meeting. These lectures are not intended for members of the Association but for the general public, and the large audiences which attend them show that very many people are interested in simple accounts of scientific work and progress in certain fields. Such descriptive lectures, however, do little more than titillate the minds of most of the hearers, and nothing to impress them with the conviction that science is the greatest social factor in modern civilisation. Wonder may be excited by experiment and exposition, but it needs to be associated with confidence in the guidance which science can give if our social and industrial conditions are to derive the best advantages from progressive knowledge. At least one of these public lectures should be devoted each year to the advocacy of science and scientific methods in national affairs, instead of making them all informative displays of achievements in selected fields.

Outside the Section rooms (where scientific workers may be permitted to use their own forms of technical expression) and beyond the lecture halls (where experienced speakers successfully hold the attention of assemblies of citizens) is the general public as a whole, reading the daily and weekly newspapers and expecting to be informed in its own language of important scientific developments of all kinds, however intricate they may be—as, for example, the constitution of the atom, the quantum theory, the principle of relativity, or the significance of cell structure. To provide this great group with the pabulum it is capable of digesting is a task which most research workers prefer to leave to others; and rightly so. Good service is, however, rendered to science by writers who can present difficult subjects in attractive literary form without departing essentially from permissible limits of accuracy—large though these may seem to be to precise investigators. There are such contributors to the general periodical press, and we think that every encouragement and assistance should be given to them. The more that the public is made to understand the fertility and the power of science the greater will be the trust in scientific service, and provision for scientific study and research will be correspondingly increased.

In the British Isles, little attempt has been made to secure wide publicity for scientific institutions and work, with the result that they are almost unknown outside scientific circles. The publications of the National Physical Laboratory, for example, are altogether inadequate to give even industrialists an idea of the work carried on in that institution. On the other hand, the U.S. Bureau of Standards issues frequent Bulletins dealing broadly with topics in which practical men are interested and in which developments have recently taken place. The U.S. National Research Council also publishes a number of useful Bulletins surveying the state of knowledge of various scientific subjects and bringing together important data. No institution or society in the British Isles issues anything comparable with these Bulletins: most of them seem, indeed, to be content to hide their light under a bushel, so far as the outside world is concerned, and to discourage any attempts made to extend the zone of illumination.

We do not suggest that scientific and technical societies should add a publicity service to their functions: they are primarily intended for the reception and discussion of new contributions to knowledge, and their concern is the interests of their fellows rather than the attention of the public. The British Association is on a different footing, in that no technical qualification is required for membership and that it sets out deliberately to create interest in science in the centres where the annual meetings are held, and beyond them by the reports of its proceedings. The presidential addresses, published annually for the Association by Mr. John Murray under the title "The Advancement of Science" (price 6*s*.), though often somewhat special in style and scope, constitute the best annual record of the position of scientific subjects of prime importance. Probably few men of science are capable of following intelligently all the subjects reviewed in these addresses, and the general public may therefore be pardoned for not comprehending most of them. To students of science, however, whether as a professional occupation or as a leisure hour pursuit, the addresses are invaluable as authoritative statements of scientific fact and theory, and the volumes containing them should be in the library of every one who finds satisfaction in pondering over the great problems with which modern science deals.

Though the British Association welcomes membership from the general public, it is not too much to say that the presidential addresses, and most of the papers presented to Sections, are intended for audiences of special scientific workers. In the case of a body like the British Medical Association, membership is limited to professionally qualified men, and in the Sections, therefore, no attempt need be made to deal with scientific subjects in popular terms. With its mixed membership, however, the British Association is in a

different—and also more difficult—position. Interpreters are needed, if not in the Section rooms themselves, then in the public press. Leading newspapers prefer that their own correspondents or contributors should perform this function, but there are many others which would gladly make use of notes and articles on scientific subjects suitable for the general reading public.

In the United States an institution entitled "Science Service" was established a year or so ago to provide such popular articles as a scientific news syndicate, and it now supplies about fifty American newspapers, and several in Canada and other parts of the world, with news Bulletins sent from Washington every day except Sunday. "The first consideration in a Bulletin story," says a circular of instruction to writers of articles, "is to tell of or interpret a scientific event. But the news stories must be so well written that large national newspapers will use them without rewriting or revision, either in form or language. Write your story so that those who know nothing about science will understand and want to read it. Weave in the scientific background that the man in the street does not have. Use simple words. Make your story as graphic as if you were talking about it." It is pointed out, in addition, that "'By Science Service' must stand for accuracy of content and implication."

In order to establish this publicity agency for science, a generous benefactor gave the sum of one million dollars to a Board of Trustees which includes among its members several of the most distinguished men of science in the United States. The whole field of scientific activity everywhere is covered by "Science Service," and the Bulletins are first-rate examples of what can be done to present scientific progress in popular and yet accurate form. We understand that the demand for the Bulletins from newspapers is now sufficient to make this admirable news agency practically self-supporting.

Here, then, we have an excellent example of what can be done successfully for the popularisation of science; and it is obvious that the constitution and methods of such an organisation are very different from those of the British Association, though the aims of both are "to promote general interest in science and its applications." We believe that the National Union of Scientific Workers contemplates establishing a similar scientific news agency to that of "Science Service," and a beginning has already been made by the British Science Guild by the issue of Publicity Pamphlets sent to the newspaper press for reproduction in whole or in part without payment. Since January 1921, the Engineering Foundation of New York has been issuing a series of such "Research Narratives," each containing the story of some research, discovery, or notable achievement in science or engineering. In one form or another these narratives have found their way through practically the entire range of the public press in America as well as the technical journals.

It is clear, therefore, that we in the British Isles are much behind the United States in the provision made for publicity for science. Our scientific societies are second to none, and the number and value of papers published by them are higher now than ever they were, yet no adequate agency exists to extend the knowledge of this work beyond scientific circles and thus to create in the public mind a feeling of pride in our scientific achievements. A great opportunity awaits the benefactor who will provide a liberal sum to establish a British science publicity service comparable with what has proved so effective in America. Political, social, religious, temperance, labour, and scores of other organisations regard it as a duty to carry on their propaganda by means of leaflets and like publications, but science is content to keep its message to itself. It is no wonder, therefore, that the community understands so little of the value and meaning of science. Let us hope that means will soon be forthcoming to establish a bureau which will not only make the proceedings of annual meetings of the British Association widely known and easily intelligible, but will also, throughout the year, continue to interpret scientific advances to a world eager to learn of them but unacquainted with the technical vocabularies in which they are commonly expressed.

Science and Man.

Science and Civilization. Essays arranged and edited by F. S. Marvin. (The Unity Series, VI.) Pp. 350. (London: Oxford University Press, 1923.) 12*s.* 6*d.* net.

THE history of science is by no means a record of steady progress. It was born among the Ionian Greeks, who were the first to speculate intelligently, on the basis of observed facts, "how things grow" and "how they behave," these being the meanings of their two words *physis* and *nomos*, so inadequately represented by *natura* and *lex*. It is often said that Greek science was unsound, being based on brilliant guesswork instead of careful investigation. The Greeks certainly loved bold and sweeping generalisations, but modern biologists, including Charles Darwin, have thought no praise too high for Aristotle, and the achievements of Greece in mathematics, astronomy, and medicine are now held to be scarcely less notable. It must, however, be admitted that the

ancients were handicapped by the want of scientific instruments, and that their backwardness in invention was partly due to an erroneous standard of values. If European nations still think it a finer thing to be an orator than a scientific inventor, that is a prejudice which we owe to the Greeks.

The Roman "steam-roller" was not favourable to originality and intellectual progress. After Galen (about A.D. 200) a Sahara of scientific barrenness begins, a dreary waste from which European history emerges only in the sixteenth century. Neither Hellenistic philosophy nor Catholic Christianity did anything to stop this barbarisation, the inevitable result of the long orgy of superstition, massacre, and pillage which we call the Dark Ages. Mankind cannot afford to forget that a measure of stability in political and social conditions is necessary not only for progress but also for the preservation of the gains of the past. The seven hundred years which followed the break-up of the Western Empire might have been blotted out of history without any great loss.

The greater part of Mr. Marvin's excellent volume of essays is devoted to modern problems. The writers admit frankly that the materialistic trend of science in the nineteenth century was the result of its unequal development. Biology advanced more quickly than psychology, and the sciences of inorganic nature were ahead of biology. The tendency to reduce life to mechanism is being abandoned in response to protests from science itself, and the problems of conscious life are seen to involve metaphysical questions with which the older generation hoped to dispense.

Prof. Whitehead, as is well known, thinks that the theories of Einstein will have a revolutionary effect on our conceptions of space and time. "The whole synthesis of the seventeenth century has to be recast. Its time, its space, and its matter are in the melting-pot—and there we must leave them." It will take many years before this judgment can be either affirmed with confidence or denied. There is reason to think that at present Continental thinkers are not prepared to go quite so far as Prof. Whitehead and his friends. There is no doubt that Einstein has made a great mathematical discovery; but we may be permitted to doubt whether a mathematical discovery is likely to give us a new philosophy.

Prof. Arthur Thomson deals judiciously with post-Darwinian biology, and does not talk, as some are rashly doing, about "the abandonment of natural selection." But I cannot agree with him when he says that "no conflict should be possible between religion and science, unless we try to speak two languages at once," or that "scientific and religious concepts are incommensurable." The assumption which underlies such statements is that science deals with facts and religion with values, and that it is possible to keep these two aspects of reality apart. I maintain, on the contrary, that a fact without value is no fact, and a value without fact no value. The two cannot be separated, and the salutary rivalry of scientific and religious truth must continue as long as men take both seriously. It will not do for science to say to religion, "Leave me alone and I will leave you alone."

Mr. Julian Huxley's long essay on science and religion takes a different line. It is interesting not only for the discussion on the place which science can find for the conception of God, but for the confident tone in which the author declares his conviction that the organic is evolved from the inorganic, through the development of colloids from smaller molecules. "Thus the forms of life, simple at first, attained progressively to greater complexity; mind, negligible in the lower forms, became of greater and greater importance, until it reached its present level in man." Mr. Huxley would not maintain that this theory has been demonstrated; but it seems probable that the monistic view of the structure of the universe will in time be generally accepted. The alternative theory that animated spores came to the earth from other bodies gives no explanation of the origin of life, and has difficulties of its own.

I am less satisfied with this writer's attempt to justify a theistic philosophy by setting the progress which he finds to be the law of organic evolution against the pessimistic conclusion based on the second law of thermodynamics. For even if we assume that increasing complexity in living organisms carries with it increasing value, the phase of evolution through which life on this planet is passing is but a transitory episode, which will probably be followed by a reverse process of involution, when our globe becomes less favourable to the higher forms of life. In any case, planetary progress can be only a backwash in the universal current which, if the aforesaid law is true, is carrying all matter towards immobility and final death. No satisfying theism can be erected on this basis. It would surely be better to assume that whatever power wound up the clock once can wind it up again, and that the life of the universe is perpetual, as its Creator is eternal. We are then free to believe in a God whose being is above the recurrent births and deaths of stellar systems.

Mr. Marvin, however, pins his faith on progress in time, and ends the book with a characteristic editorial chirp. It is probably true, as he says, that humanity is still young, and capable of achievements still undreamed of. Hope for the future is reasonable, so long as we do not make a religion of it.

W. R. INGE.

The Manufacture of Acids and Alkalis.

The Manufacture of Acids and Alkalis. By Prof. George Lunge. Completely revised and rewritten under the Editorship of Dr. A. C. Cumming. Vol. 1: *Raw Materials for the Manufacture of Sulphuric Acid and the Manufacture of Sulphur Dioxide.* By W. Wyld. Pp. xiii+558. 36*s.* net. Vol. 5: *The Manufacture of Hydrochloric Acid and Saltcake.* By Dr. A. C. Cumming. Pp. xv+423. 31*s.* 6*d.* net. (London and Edinburgh: Gurney and Jackson, 1923.)

THE various treatises on different departments of applied chemistry which chemical literature owes to the genius and industry of the late Prof. Lunge are among the classics of chemical technology. They have passed through many editions in fairly quick succession, and their betterment and revision was the constant employment of their author's leisure, no pains being spared by him to make them an accurate and faithful reflex of the state of contemporary knowledge of the several subjects with which they were concerned. Prof. Lunge enjoyed many opportunities and facilities to this end. As professor of applied chemistry in the Zurich Polytechnic, one of the best equipped and most famous schools of chemical technology in the world, he was an acknowledged authority on many branches of manufacturing chemistry, and particularly on the special branches dealt with in the books under review. The manufacture of acids and alkali was in fact the chief chemical industry in which Dr. Lunge was employed during his sojourn in England and before his appointment to the distinguished position he occupied until his death. A brief account of his life and work appeared in NATURE of February 17, p. 228.

These treatises constitute, in the aggregate, a valuable literary property, and the publishers are well advised in seeking to maintain the reputation they have hitherto enjoyed as faithful and accurate accounts of the state of contemporary procedure in the special branches of chemical industry with which they deal, by entrusting their revision to competent authorities, and in issuing new editions at comparatively short intervals.

It might be thought that in the case of an industry so well established as that of the manufacture of alkali and of the industries which are so closely associated with it, the last word had been said in respect to processes and procedure. Such, however, is very far from being the case, as even a very superficial comparison of successive editions of these treatises will make manifest. The changes may not in all cases be fundamental or subversive, but they are more or less important as tending to efficiency and economy, and no account of the contemporary condition of the manufacture would be adequate without reference to them.

The general superintendence and editorship of the new editions of these manuals has been entrusted to the competent hands of Dr. A. C. Cumming, under whose direction they have been completely revised and rewritten. The volume on raw materials for the manufacture of sulphuric acid and of sulphur dioxide has been assigned to Mr. Wilfrid Wyld, who has been associated with important concerns in Yorkshire and elsewhere, and brings to his task the fruits of a large experience.

In a general preface prefixed to the several volumes Dr. Cumming has given a brief account of the history and development of the late Prof. Lunge's literary labours in connexion with applied chemistry, which is of interest as showing how the scope of these labours was gradually enlarged so that it became practically an encyclopedia of the many chemical industries. The first English edition of the volume on sulphuric acid appeared in 1879, and the last edition in 1913. This was followed in 1917 by a supplementary volume on sulphuric and nitric acids. This was the last of Lunge's contributions to this special field of chemical technology.

The book under review shows no very striking features in the way of new developments. As regards raw materials, the most important change is the revolution in the production of commercial sulphur effected by the Frasch process. This remarkable process is one of the most notable chemical engineering triumphs of the present century. In 1869 an enormous deposit of sulphur was discovered in Louisiana in the course of well-sinking in connexion with petroleum, but all attempts to work this deposit commercially failed until the genius of Herman Frasch devised the method associated with his name. Space will not allow of any detailed description of the process. Briefly, the method consists in sending down a sufficiency of superheated water and thus melting out the sulphur, which liquefies at about 116°, from the pockets in the limestone and beds of gypsum in which it occurs. The molten sulphur is then forced to the surface by means of compressed air, and of course consolidates as it cools. The book contains a fairly full account of this process, which is now worked on a very considerable scale, not only in Louisiana but also in Texas, where similar sulphur deposits have been found to occur. It has rendered America independent of all outside sources of sulphur supply, and for a time seriously threatened the existence of the Sicilian industry, of which it has destroyed the monopoly.

Mr. Wyld's account of the history of the process and of its successive developments leaves nothing to be desired in point of accuracy and completeness. It forms indeed a most interesting section of the chapter devoted to the exploitation of the natural deposits of sulphur which occur in various parts of the world.

The book, of course, deals with a great variety of processes for obtaining sulphur: from raw ores; from spent oxide in the manufacture of coal-gas; from pyrites; from sulphur dioxide, as from smeltery fumes; from sulphuretted hydrogen and sulphites and sulphides and from sulphates of the alkaline earths. These last-named processes became of the utmost importance to Germany during the War, owing to her inability to import sulphur or any considerable supply of pyrites. History affords many instances where a nation or manufacturing community under the stress of necessity, often occasioned by war, has been compelled to adopt new methods or to modify existing ones, and such modifications have frequently taken a permanent place in industry. What, however, is to be the ultimate fate of the processes which Germany was compelled to adopt remains to be determined. Certain of them have been found to be economically unsound when compared with pre-War methods, and have already been given up, but their story is interesting as a chapter in industrial progress and as showing what knowledge, skill, resourcefulness, energy, and application will achieve in overcoming obstacles which at first sight seemed well-nigh insuperable.

In an industry such as that described in this book analytical control is frequently of the utmost importance, but it is too often neglected, or only inadequately carried out, owing, in many cases, to the want of suitable methods or to the time required to make the results available to the management.

A commendable feature in the book is the space allotted to descriptions of the most suitable analytical methods at the disposal of the works chemist. The treatise in this respect becomes a veritable *vade mecum*, and should be indispensable to every well-ordered factory. The improvement of analytical processes applicable to the conditions of chemical works was a constant problem with the late director of the chemical department of the Zurich Polytechnic, and certain of the methods described in this book are the outcome of investigations made by him in conjunction with his senior pupils.

The various forms of pyrites, brimstone, and spent oxide are the usual sources of sulphur dioxide, mainly as an " intermediate " in the manufacture of sulphuric acid. For small-scale operations sulphur dioxide is made by heating charcoal or sulphur with sulphuric acid, usually of 74 per cent. SO_3 or 165° Tw. As the gas is easily liquefied, the temperature of a mixture of snow or powdered ice and salt being sufficient to effect its condensation, it may be preserved as a liquid in ordinary soda-water syphons, whence the liquid or the gas may be liberated as desired. This section of the book contains a full account of the physical and chemical properties of this compound, the modes of its detection and estimation, and of its employment in the manufacture of wood pulp and as a disinfecting and antiseptic agent and also as a bleaching agent, especially for wool, silk, straw, etc., and to a limited extent in wine-making in the form of meta bisulphite. Other sulphur compounds of which full and accurate accounts are given are sulphur trioxide and the various nitrogen-sulphur compounds. Indeed, the chemical history of the various sulphur compounds, so far as these have any relation to sulphuric acid and its manufacture, may be said to be accurate and complete.

As regards the actual manufacture of sulphuric acid, a comparison with the accounts given in the earlier editions shows what the influence of the War has been on the production of this important chemical. Pre-War plant was found to be utterly inadequate to meet the demand for this acid, as incidentally required in the manufacture of munitions, and, as is well known, it was necessary to make special arrangements to this end. Some account is given of the means installed at Queen's Ferry and other places. The section on burners for sulphur and on the plant needed in connexion with the use of pyrites has been carefully revised and brought up-to-date, and constitutes one of the most valuable sections of the work.

The volume on the manufacture of hydrochloric acid and salt-cake exhibits, perhaps in a more striking manner, the changes, almost revolutionary in character, which have overtaken this special branch of the alkali manufacture. The Hargreaves' process is no longer in operation in this country. Pan and furnace methods are still worked, but with the gradual disappearance of the Leblanc process it may be anticipated they will give way to one or other of the more modern processes described in this volume.

As the editor points out, the manufacture of hydrochloric acid is no longer necessarily connected with the manufacture of salt-cake, and fuller treatment has therefore been given to its manufacture from chlorine and to other modern developments.

The revised work is a most valuable addition to the literature of one of our staple industries, and the editor is to be congratulated on the care and thoroughness with which he has completed his task.

T. E. THORPE.

National Eugenics.

(1) *Eugenical Sterilisation in the United States.* By Dr. H. H. Laughlin. Pp. xxiii+502. (Chicago: Psychopathic Laboratory of the Municipal Court of Chicago, 1922.) n.p.

(2) *Eugénique et sélection.* Par E. Apert, L. Cuénot, Le Major Darwin, F. Houssay, L. March, G. Papillaut, Ed. Perrier, Ch. Richet, G. Schreiber. (Bibliothèque générale des Sciences sociales.) Pp. iii+248. (Paris: F. Alcan, 1922.) 15 francs net.

"NATIONAL Eugenics is the study of those agencies under social control which may improve or impair the racial qualities of future generations." Galton thus linked the word "national" to eugenics. The problem in its fundamental biological aspects is in one sense the same for all nations, but to each nation it may present different sides and provoke different methods of attack, if indeed it is attacked at all. The experiences of one nation are, nevertheless, worthy of observation by all.

(1) From this point of view, the first part of Dr. Laughlin's book is of interest. This part consists of a detailed analysis, written from a lawyer's point of view, of the sterilisation laws enacted in the United States prior to January 1, 1922, with summaries of the extent to which they have been put into practice in different States and a full account of the litigation arising out of them. Fifteen States have had, and nine still have, sterilisation laws, some mandatory and some optional. The scope of these laws varies from State to State, but in no case extends beyond certain inmates of State, county, or municipal institutions. The consent of the relatives has in general been easily obtained. There is very great variation in the opinions quoted of the executive boards and superintendents, and consequently in the extent to which the laws have been put into practice.

From 1907 until January 1, 1921, 3233 operations in all were carried out under the laws, and of these 2558 occurred in California (1009 being due to a single institution). Nebraska comes next with 155 cases. In Wisconsin, Connecticut, and North Dakota the law is still being applied, but to a very limited extent. In Washington, where the object is purely punitive, only one case has so far occurred. In six of the fifteen States the law has been repealed or vetoed, and in three it has become a dead letter. In test cases, violation of the State or Federal constitution has been argued chiefly on the grounds of class legislation, cruel or unusual punishment, or denial of equal protection of the laws. In five States the courts have held the sterilisation laws unconstitutional, but the quoted opinion of various American legal experts differs more on their expediency than on their constitutionality. The history of the working of these laws indicates that, in the country as a whole, public opinion is not at present behind them.

As an exhaustive historical record and guide to existing practice in the United States this compilation will no doubt prove a useful book of reference for those practically concerned with sterilisation in the legislative, legal, and administrative fields. As a contribution to the scientific discussion of the social and biological aspects of the problem it has less weight. The section on eugenical diagnosis is intended "to serve the legislator in his efforts to weigh the matter in its entirety." It is not easy to see, however, that this purpose can be achieved by the somewhat crude and uncritical summary offered of Mendelian theory and its application. The student will find the book overloaded with detail (incidentally there are discrepancies between text and table in the indentification numbers of individuals in the case pedigrees), but it contains a great deal of information, not easily accessible hitherto, of which the eugenist should not be ignorant.

(2) "Eugénique et sélection" is a collection of papers, most of which were delivered as lectures during 1920–21 at the meetings of the "Société française d'Eugénique," and are devoted mainly to a discussion of the consequences of the War in France from a eugenical point of view. It includes an earlier paper by the late vice-president of the Society, Frederic Houssay, in which, starting from a series of experiments on six generations of hens, he argues that there is a degeneracy of those in easy circumstances due to the abuse of food, each generation poisoning the next through toxic excretions into the germ cells.

Dr. Apert deals with the effect of the War on the health of the French nation. The two chief qualitative results he finds are an increased tendency to tuberculosis and the expectation of a series of infantile generations of lessened resistance to disease. To these he adds alcoholism and syphilis as active menaces to the French race. M. Lucien March treats the question from a quantitative aspect. He estimates the total loss of population to France (including the deficit of births) directly due to the War as 3,000,000 people. He examines the size of family in various classes, and gives as the three fundamental factors on which the birth-rate depends: (1) the cost of the child before he is self-supporting; (2) the chance the child has of maintaining himself in at least as good circumstances as his parents; and (3) the opinion that the parents hold of (1) and (2). He outlines the various steps taken in France to encourage natality, among which may be noted the existence of more than 70 employers' associations which give benefits for each

child of an employee, but safeguard at the same time against preferential employment of single men by basing each employer's contribution on the total salaries paid by him. None of these measures are contrary to eugenical principles; they are, however, aimed directly at quantity instead of quality. From the psycho-social aspect and a consideration of the statistics of insanity and suicide Dr. Papillaut finds in the War confirmatory evidence of the predominant effect of heredity over environment. War effect on marriages is discussed by Dr. G. Schreiber. He regards the mixed marriages of French women with men of other Allied nationalities as a probable benefit to the French nation. He urges the establishment of a medical examination before marriage that shall be compulsory but carry no legal sanction.

The volume closes with an address on some zoological aspects of eugenics delivered by M. Lucien Cuénot at the second National Congress of Eugenics in 1921. Starting from the Mendelian conception of unit factors susceptible of mutations which appear as somatic changes, he discusses the position of Mendelists with reference to the heredity of acquired characters and the origin of adaptations. On the first question the author retains an open mind in the light of Guyer and Smith's experiments on the inheritance of acquired eye defect in rabbits. He puts the case well for preadaptation—*i.e.* the surroundings as a consequence of the structures with which the animal is born and not *vice versa*—and reviews the difficulties of interpretation of the mechanical perfection of certain structures in relation to their apparently small utility. Such difficulties lead him to feel that there is something wanting in the conception of evolution, some general law that has still to be discovered.

A collection such as this, which treats the subject from so many points of view, can do no more than touch the surface, but it is well adapted to fulfil its aim of giving the French-speaking public an idea of the object and extent of the science of eugenics as defined by Galton.

The Animal Parasites of Man.

Animal Parasites and Human Disease. By Dr. Asa C. Chandler. Second edition, revised. Pp. xiii+572. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 22*s.* net.

IT is unfortunate that animal parasitology, the youngest branch of preventive medicine, is still regarded by many people as a field of knowledge that is of little moment outside tropical and subtropical regions. Everybody acknowledges the direct connexion with man's welfare of the parasites dealt with in the sister science of bacteriology; but the parasitic protozoa, helminths and arthropods, which are responsible for so much human suffering, are scarcely thought of by the general public. Indeed, even the average physician of temperate climates seems to be satisfied to have quite a superficial knowledge of this branch of his profession; yet these parasites, which are concerned with the most varied diseases and morbid conditions, have been found to be widespread and in abundance, wherever they have been looked for. There are many popular books on the animal parasites of economic importance, but remarkably few on those which affect human health. It is admittedly very difficult to write an attractive book, in popular language, on any scientific subject, and when the book deals with such objects as tapeworms, fleas, and lice, the general reader is apt to put it aside with a faint feeling of disgust. But among these and other such despised creatures are many the life histories of which are of much interest, and on account of the practical importance of their relations to man, they should claim the attention of all.

Dr. Chandler describes his book as a compilation, but it is more than that: the subject is presented in a fresh and interesting manner, and the book shows evidence of much care and skill in the selection of its contents. The information given has been brought thoroughly up-to-date, and all recent work of any importance is referred to. A sufficient account is given of the spirochætes, which the author considers to be "on the vague unsettled border-line between bacteria and protozoa." Many, perhaps, would be inclined to adopt a more critical attitude towards the phenomenon of "granule shedding" in these organisms. The subject of the prevention of syphilis is discussed in a broad and logical spirit. The leishmania bodies, trypanosomes, intestinal flagellates, and amœbæ are well described, and there are short accounts of the diseases to which they give rise. The author seems to accept without demur the parasite recently described by Kofoid and Swezy, and named by them *Councilmania lafleuri*. The parasitology of malaria is adequately dealt with, and the Rickettsia organisms are alluded to. The life history of the liver fluke is told at length, and illustrations and descriptions are given of the other trematodes which occur as human parasites. The "worms" are all figured, and the salient points of their bionomics mentioned. Ten pages are devoted to *Trichinella spiralis*, and about as many to the various species of Filaria. The rest of the book, about two hundred pages, is concerned with the arthropoda. The entomological section is particularly good, and contains an excellent account of the habits and distribution of those insects which are harmful to man.

Throughout the book, adequate reference is made to the diseases caused by animal parasites, and to the methods employed for controlling the latter. With a few exceptions, the illustrations are good, and they possess the commendable feature that, where the organism is not drawn of the actual size, the magnification used is always indicated.

It is to be hoped that this excellent book will help to arouse a more general interest in a subject with which all are personally concerned. Although it is written in a popular style, the book is always accurate; any one who reads it carefully will acquire the foundation of a good general knowledge of the animal parasites of man, and, if he wishes to pursue the subject further, he will find that he has nothing to unlearn.

H. J. Walton.

Our Bookshelf.

Spezieller Kanon der zentralen Sonnen- und Mondfinsternisse, welche innerhalb des Zeitraums von 600 *bis* 1800 *N. Chr. in Europa sichtbar waren.* Von J. Fr. Schroeter. Pp. xxiv + 305 + cl Tafeln. (Kristiania: Jacob Dybwad, 1923.)

In this volume Schroeter continues Ginzel's "Spezieller Kanon der Sonnen- und Mondfinsternisse" (1899), which contained all eclipses visible in an area between 10° W. and 50° E. of Greenwich, and between 30° and 50° N. latitude, from 900 B.C. to A.D. 600. Schroeter's scope is somewhat different. He gives all central eclipses of the sun and all total eclipses of the moon visible in Europe between A.D. 600 and 1800. For partial eclipses of the moon between those dates it is still necessary to turn to Oppolzer. It will be observed that the area covered by Schroeter differs widely from that covered by Ginzel, and results from the substitution of a European for a Mediterranean civilisation. One result of this selection is that the present volume is of little use for the study of the numerous eclipses recorded in the history of non-European countries. Perhaps some day each continent will have its own equivalent to Schroeter.

The elements of eclipses used in this volume are based on the same constants and computed by the same formulæ as those determined by Ginzel and used in his "Spezieller Kanon," but the errors attaching to the results are far less at the dates for which these tables are constructed than for the distant dates with which Ginzel deals. One advantage of Schroeter's volume over Ginzel's is that, while an exact computation from Ginzel's elements can only be made by reference to the formulæ contained in Oppolzer's "Canon der Finsternisse," Schroeter prints these formulæ in his introduction. Another difference is that where Ginzel contents himself with computing the northern and southern limits of the total or annular phase of a solar eclipse, Schroeter computes also the curves of nine digits magnitude. Again, while Ginzel has one large-scale map showing all the zones of total and annular eclipses for each century, Schroeter, though limiting himself to a smaller scale, has a separate map for each eclipse. There is, however, nothing in Schroeter to correspond to the detailed discussion of each historical eclipse which is one of the most valuable features of Ginzel's work.

This work is likely to be of more use for historical than for astronomical studies. Probably it will be used mainly by those astronomers who may be called upon to assist students of history.

Modern Gas Producers. By N. E. Rambush. Pp. xix + 545. (London: Benn Bros., Ltd., 1923.) 55*s*. net.

We have nothing but commendation for this treatise on modern gas producers. It is a finely conceived work admirably executed. The author is one of the few equipped with theoretical knowledge of the thermal processes involved in producer gas manufacture, and with the extensive acquaintance with technological aspects of the matter required for an adequate treatment of the subject. Of this, the work before us is sufficient witness. Four sections devoted respectively to (1) the theory of the formation of producer gas, (2) types of gas producers, (3) control and operating principles of producer gas plants, and (4) the utilisation of producer gas, are comprised in the book. The theory of the subject is developed in an extremely clear manner. We think the author has succeeded in his declared endeavour to describe plants and types of producers quite impartially. A rather careful reading of the work has left us quite undecided as to what plants the author has been personally connected with in a professional capacity. This is eminently desirable in a work of this nature, and in marked contrast to what we have found in at least one volume of the present series of publications. Specific features of design commonly employed in practice and of a number of special designs are set out in considerable detail. This section might easily have degenerated, as has happened in too many cases recently, into a highly priced trade circular. It has not done so, but is extremely readable and informative, and contains much valuable data relating to actual trials of the various plants. The third section is commendably brief, as fuller particulars of the testing of fuel and gas are contained in another volume of the same series. Typical applications of producer gas in the gas engine, gas turbine, furnaces, etc., and the relative efficiencies in use of various grades of gas, are briefly treated in the last section.

The work is characterised by a number of extremely valuable tables and graphs facilitating calculation. There are altogether 356 drawings and illustrations, all beautifully executed and reproduced. An adequate index is provided. We think the high price of the volume justifiable, and prophesy an assured premier position for the work in the literature of producer gas technology.

J. S. G. T.

Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Years 1922, 1923. First Section: The Production of Air-dried Peat. Pp. vii + 146. (London: H.M. Stationery Office, 1923.) 5*s*. net.

Mechanical methods of winning peat in operation in Europe and Canada are dealt with in this report, in which are discussed the difficulties encountered in winning the air-dried fuel, and possible schemes for

winning it on a very large scale. It describes also the investigations on the winning and the utilisation of peat undertaken by the Fuel Research Board during the past four or five years. These investigations were the preparation of air-dried machine peat in an Irish bog, but by well-known Continental methods and on a very small scale, together with the establishment of the facts, long known abroad, that machine peat dries more uniformly than slane-cut peat, and has a higher value than slane-cut peat of the same calorific power.

The report is disappointing inasmuch as it shows that the Fuel Research Board has not made any serious attempt to grapple with the problems of the winning and the utilisation of peat. On the other hand, it is valuable since it shows that several attempts to solve these problems are being made in Germany, Sweden, Russia, and Canada. Prof. Purcell's detailed and critical descriptions of the peat industries of northern Germany, Sweden, and Canada are interesting and instructive. One would have expected, however, that the Fuel Research Board's contribution to the solution of these problems during the past four or five years would have been considerably more than a full description of what other and poorer countries are doing in regard to these important matters. HUGH RYAN.

El Arte de los Metales (Metallurgy). Translated from the Spanish of Alvaro Alonzo Barba, by Ross E. Douglass and E. P. Mathewson. Pp. ix + 288. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 17*s.* 6*d.* net.

THE earliest known work on American metallurgy was written by Alvaro Alonzo Barba, a priest of Potosi in Bolivia, and was published in Spain in 1640 and several times reprinted. This book, of great historical interest, has now been fully translated by two American metallurgists, and forms an important technological document. The most valuable feature of the work is its detailed description of the methods of extracting silver from its ores practised in Bolivia, a region in which metallurgical skill had at that time attained to a very high level. Amalgamation and the processes connected with it are here described minutely, and in a straightforward fashion, with simple diagrams. Barba was not a profound thinker, and accepted the current superstitions regarding ores and minerals without question, comparing in this respect very unfavourably with his great predecessor Agricola; but his shrewdness in practical matters and his close acquaintance with the work of smelting and extraction on a large scale are evident throughout. The translation, except for a few explanations of technical terms, inserted in brackets, is not annotated, so that the student will do well to read it in conjunction with Hoover's remarkable translation of Agricola, with its abundant historical notes. C. H. D.

An Introduction to Stratigraphy (British Isles). By Dr. L. D. Stamp. Pp. xv + 368. (London: T. Murby and Co., 1923.) 10*s.* net.

THIS is a distinctly original work that will be of service to very many students who are unable to follow current literature as it appears. Dr. Stamp brings together, with good references, results recently obtained by others, but adds to them by his personal knowledge and his methods of appreciation. Sections showing the mode of deposition of various series, and sketch-maps of their distribution, give unusual interest to what might have been a mere description of the part played by each formation in the structure of the British Isles. As examples, we may take the general map and the small local section (pp. 146 and 147) dealing with the Millstone Grit, and the suggestive map (p. 170) of Britain in the Permian period, with its stream-notched uplands supplying material to the basins in the midlands and the south. Not content, the author gives us an enlarged detail of the Cornubian area on p. 175. Dr. Stamp (p. 241) is not so bold as Mr. E. Greenly in carrying his Cretaceous strata across the peneplane of Snowdonia. He writes throughout, in spite of very concise limits, as if he were actually viewing from an aeroplane the geographic features of the past. G. A. J. C.

Primitive Tider i Norge: En oversigt over stenalderen. Av Haakon Shetelig. Pp. iv + 380. (Bergen: John Griegs Forlag, 1922.) n.p.

DR. SHETELIG, in his introduction, points out that in few countries in Europe does written history begin at so late a date as in Norway. This gives to the study of prehistoric antiquities in that country a position of peculiar importance. For archæologists generally the prehistory of the area of which Norway forms a part is also of particular interest, especially in its earlier stages, in view of its relation to that of the rest of Europe; it is there that we find the evidence for the earliest stages of neolithic culture. On both accounts, therefore, Dr. Shetelig's study of the Stone Age in Norway is welcome. For students outside his own country its value will lie largely in the author's survey of the latest views of Norwegian men of science on Scandinavian archæology and the relations of Norway in the Stone Age to the rest of this area. From this point of view his chapters on the first appearance of man in Norway, the transition to the New Stone Age, and the kitchen-middens are particularly worthy of note, as also is his account of Stone Age art, the trade in amber, and the use of jade.. The book is fully and admirably illustrated.

How to Paint Permanent Pictures. By Prof. M. Toch. Pp. 105. (London: Scott, Greenwood and Son; New York: D. Van Nostrand and Co., 1922.) 7*s.* 6*d.* net.

THE reviewer has often wondered, when looking at paintings of great merit which are gradually fading away or cracking in pieces, why artists do not spend a little time in learning something about their materials. In many cases they are probably at the mercy of the dealers. It would seem desirable, therefore, to direct attention to this small book by Dr. Toch, which deals with the properties of pigments simply yet scientifically, and should be valuable to all who paint pictures. In it are described those colours which are permanent and those which may be expected to fade away more or less completely with lapse of time. Varnishes are also discussed.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Inheritance of Acquired Characters in Alytes.

FOR those who are not concerned with the details of this debate I suppose that the critical sentence in Dr. Kammerer's letter (NATURE, August 18) is that in which he expresses himself as follows: "I willingly admit that the traditional explanation of the pads, namely, that they are produced by friction with the skin of the female, may possibly be a fable," adding references to passages in which he had already discussed alternative hypotheses. But those alternatives were ultimately rejected, and his final judgment was that until the assumption that the pads arise through functional adaptation can be replaced by a better, it remains the only acceptable account.[1] Remarking that the alleged nuptial pads may possibly be due directly to life in water and not an adaptative response, he now tells us that the relevance of his observation to the theory of heredity is in either alternative the same But is it?

The heavy task of searching for evidence of hereditary transmission of acquired characters has clearly been undertaken in the single hope, forlorn indeed, but undying, that the difficulty created by the existence of the *adaptative* mechanisms might be removed. They constitute a very grave difficulty in all theories of evolution. Various evidence, mostly ambiguous but as a whole significant, does suggest that in special cases, by violent treatments, the germ-cells of animals may be affected, more or less injuriously, and that the consequences may persist at least for some generations; but that does not help us with the problem of adaptation. Dr. Kammerer's admission would relegate the Alytes pads to that class of phenomena. Had this been all that was claimed, I should have felt some interest in the matter, but less.

The significance of the story is now reduced. In 1909 we were told that nuptial callosities appeared on the *thumbs* of treated males, and that all the males of the "F_4" generation had them. The claim that this was a true adaptation was made without any qualification whatever. This led to my request (made privately in 1910, published in 1913) that a specimen should be produced. In 1919 we hear for the first time that the swellings appear in various other regions of the arms. When at length a specimen is produced, I find it mounted to display a dark thickening on the palm of the hand, a place which, unless I am mistaken, had not previously been specified. That this was the structure to which Dr. Kammerer particularly wished to direct our attention appears also from the fact that the new photograph sent to Prof. MacBride, which I have not had the privilege of inspecting, was made from it. So far as I am aware, this is the only specimen ever exhibited publicly.

Dr. Kammerer complains that I did not at the Linnean meeting produce "a single one of the many objections" alleged in my letter of June 2. His memory is at fault. My chief objection was the position of the pad on the palm. Any one who attended the meeting will know that I directed very prominent attention to this feature. To make my objection clear and conspicuous I asked in German: "*Das Männchen umarmt sein Weibchen—so*—[turning the backs of my hands inwards]—*nicht?*" To which Dr. Kammerer as I thought nodded assent. No one can have forgotten that the next speaker took me to task for this, saying by a slip, induced I suppose by what he had seen of the specimen, that "of course" the common toad clasps the female with the palms towards her.

Why Dr. Kammerer should think that in writing of his diagrams I had in mind a book of Plate's (which I hear of for the first time), I cannot imagine; for I added the exact references to his own paper of 1909, Figs. 26 and 26*a*. The pictures which I threw on the screen, illustrating the fantastic story of Mendelian segregation in respect of the modified habits, will also be found in his paper 12 *Flugschr. d. Deut. Ges. f. Zuchtungskunde*, 1910, and again in *Natur*, Munich, December 12, 1909, papers to which all readers desiring to see the prodigious scope of the original claims should refer. A more detailed though unillustrated account appears in *Mendel Festschr.*, Brünn, 1911.

I do not propose to rebut the minor allegations made by Dr. Kammerer. Several of these would not have been made had he seen my letter in NATURE of July 3, 1919. The answers to the rest will be evident to those who have followed the discussion.

The question remains, what is the real nature of the swellings in the animal exhibited? That on the palm did not look like a nuptial pad. What there may have been on the back of the hand I do not know. I made no statement about it, though Dr. Kammerer says I did. I might no doubt have asked to see the back, but I had no reason to suppose there was anything more to see. The palmar mark was what we were shown for our conviction. This looked so unlike what I remembered of real *Brunftschwielen* that I did ask in the discussion, "*Wie wissen Sie, dass sie Brunftschwielen sind?*" I knew our frog and toad very well, and, of course, Lataste's drawings of sections, but it was some years since I had looked at other species. I thought that perhaps, where the development is slight, as in *Rana agilis*, the external appearances might be less unlike what I had seen in the Alytes, but they are not. When with that specimen fresh in mind I examined a series of nuptial pads in various Batrachia I realised still more vividly how widely the structure in the Alytes differed from the real thing. In my letter, therefore, I laid stress on the dissimilarity.

Dr. Kammerer writes that his specimen was examined out of the glass by Sir Sidney Harmer and Mr. E. G. Boulenger, but we are not told whether they are among the "dozens" now convinced. Mr. Perkins states that "the epidermal spines are very obvious in the intact specimen." He is the only independent witness, of those whose opinions have reached me, who claims to have seen anything so definite.

I have a strong curiosity to see this Alytes again. Dr. Kammerer challenges me to supply him with apparatus for the purpose of photographing it. I will make a different offer. For the opportunity of examining it at leisure in the British Museum, where comparative series are available, or if preferred in Prof. MacBride's laboratory, I am willing to pay 25*l*. either to the Versuchsanstalt or to other appropriate authority. Plenty of responsible people travel between Vienna and London, and there should be no difficulty in arranging for safe conveyance.

W. BATESON.

The Manor House, Merton, S.W.20,
August 26.

[1] 1919, p. 353: "Bevor also unsere Annahme, die Schwielenbildung geschehe durch funktionelle Anpassung, durch keine bessere ersetzt werden kann, bleibt sie die einzig akzeptable."

A Possible Origin of the Nebular Lines.

THE hypothesis that the lines of unknown origin in the spectra of nebulæ are due to the atom of some hitherto undiscovered element ("nebulium") is not the only one that may be advanced. The recently developed quantum theory of band spectra makes it at least possible that these lines could have their origin in a *molecule* with small moment of inertia composed of atoms of those elements which are known to exist in nebulæ. It is proposed in this letter to show that the existing astronomical evidence is not in contradiction to this alternative hypothesis, and also to indulge in some speculation as to the nature of such a molecule.

The Nebular Spectrum.—The absence of band heads in the nebular spectrum does not necessarily preclude the possibility of a molecular origin. In a band spectrum the individual lines of a single band may be arranged in a Deslandres formula,

$$\nu = A \pm 2Bm + Cm^2,$$

where m takes the successive values 1, 2, 3, etc., and the line corresponding to $m=0$ is missing. The lines, therefore, arrange themselves in a positive (R) and negative (S) branch on either side of the missing line $m=0$; the band head is due to the overlaying of one or other branch on itself, depending upon the sign of C, and occurs in general only for large values of m. To a first approximation, however, the lines in either branch are equally spaced with a separation equal to 2B, where on the quantum theory of band spectra (Sommerfeld, "Atombau," chap. 7) B is inversely proportional to the moment of inertia of the molecule. The smaller this moment of inertia the more widely spaced will be the lines, and from the Boltzmann probability factor the fewer there will be of them. Accordingly, if the hypothetical molecular carrier of the nebular spectrum has a small moment of inertia, the resultant spectrum will consist of isolated lines with no band heads—in general agreement with that observed.

Slightly more positive evidence can be gained from a closer consideration of the nebular spectrum. The important work of Wright (Lick Observatory Publications, vol. 13) has shown that the nebulæ may be arranged in a series from low excitation (strong H, no He lines) through medium to high excitation (H and strong He$^+$ lines). At the top of the accompanying diagram (Fig. 1) are shown the positions (on a wave number scale) and intensities, as given by Wright, of the nebular lines of unknown origin for B.D. +30° 3639 (low excitation) and N.G.C. 7027 (high excitation). For convenience of reference the high excitation spectrum is also repeated at the bottom of the diagram; the dotted lines shown in this spectrum are suspected nebular lines which occur in nebulæ of medium excitation, but not in N.G.C. 7027.

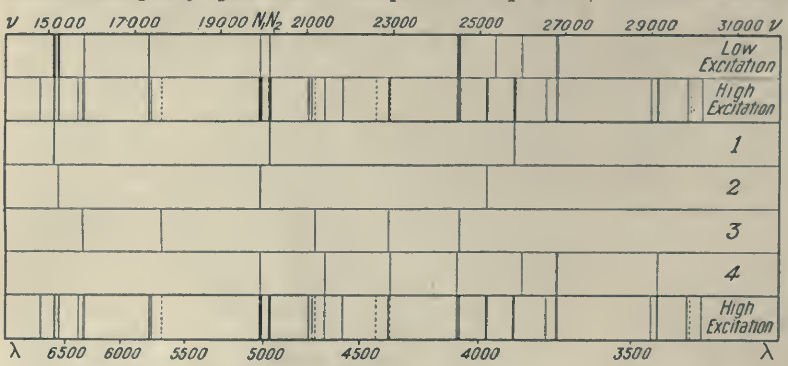

FIG. 1.

The change in intensity and in the number of the nebular lines with increase in excitation is very striking, and this fact may be used in an attempt to select band lines in the spectrum. For the intensity of a line depends primarily on the number of molecules which are in the particular quantum state m, and, according to the Maxwellian distribution of rotational velocities, with increase in excitation the maximum of rotational speeds will shift to the higher quantum numbers. Thus, for low excitation, lines corresponding to $m=\pm 1$ will be strong, but with increase in excitation the lines $m=\pm 2$, ± 3 will gain at the expense of $m=\pm 1$. Using this as a guide, a number of possible band groupings have been suspected in the nebular spectrum, and these are shown as Nos. 1, 2, 3, 4, in Fig. 1. A few words of comment may be made on these.

Nos. 1, 2.—These two groupings comprise the six strongest lines in the spectrum, including N_1, N_2, 3967, 3868. It will be noted how the maximum of intensity shifts from the red lines to the violet with increase in excitation. It has been assumed that each grouping is a positive (R) branch of a single band, and the constants of the Deslandres formula have been computed.

$$\text{(No. 1)}\quad \nu = 10915{\cdot}9 + 3916{\cdot}3m + 352{\cdot}9m^2,$$
$$\text{(No. 2)}\quad \nu = 11098{\cdot}4 + 3903{\cdot}6m + 265{\cdot}4m^2.$$

The close similarity of the constants B for each group suggests that 1 and 2 are two positive branches of a single band with zero line far out in the infra red. Curtis has found in the He_2 spectrum (Proc. Roy. Soc. A, 101, 38, 1922), a band (λ5730) with two positive branches with slightly different (12 wave numbers) values for the zero lines.

No. 3.—This suspected band contains four lines with a dubious fifth, and consists of a positive (R) and negative (S) branch with the line $m=0$ as usual missing. Using the lines with wave numbers S (1) 17679, R (1) 21219·2 and R (2) 22912·50 to compute constants, the following formula is reached:

$$\nu = 19474{\cdot}7 \pm 1770{\cdot}1m - 25{\cdot}6m^2.$$

The computed wave number of S (2) is 15832, and there is an observed line at 15836 (±3), which may be considered satisfactory agreement. The computed wave length of R (3) is 24555, and there is a strong line at 24571·5 (±0·1). The agreement is not satisfactory, the intensity relations are not satisfactory, and it is accordingly very doubtful whether this line belongs to the group. The remaining four, however, make a satisfactory group, and it will be noted that while the lines R(1), S(1) make their appearance in nebulæ of medium excitation, the intensity is transferred to R(2), S(2) in the nebula of high excitation.

No. 4.—This suspected band contains eight lines, which may be divided into a negative (S), a positive (R), and a zero (Q) branch. The designations, wave lengths, and wave numbers are given in the accompanying table. The lines marked with asterisks were used in computing the constants for the R and S branches, namely,

$$\nu = 27586{\cdot}1 \pm 1560{\cdot}6m + 7{\cdot}4m^2;$$

from this was computed in the usual way the formula for the Q branch, namely,

$$\nu = 26805{\cdot}8 + 7{\cdot}4m^2.$$

The agreement between the observed and computed values can be seen from the table below. It is sufficiently close to suggest, in view of the approximate character of the band formula used, that there may be some reality in this grouping. As usual the intensity is transferred from the lines with low quantum numbers to those with high increase in excitation. It will be noted that the line N_1 is used in this grouping as well as in No. 2, and the suggestion is that this line is a close double of a strong and weak component, the latter of which belongs to the present group.

Designation.	Wave Length.	Wave No. (comp.).	Wave No. (obs.).	
S(5)	5006·84	19967·13*	19967·13	±0·04
S(4)	4658·2	21461·5*	21461·5	0·5
S(3)	4353	22964·6	22966	5·0
S(2)	4076·2	24494·4	24525·61	0·1
S(1)	3840·2	26032·9*	26032·9	0·7
Q(1)	3728·91	26813·2	26809·87	0·2
Q(2)	3726·16	26835·3	26829·65	0·3
R(1)	3426·2	29154·1	29178·5	±2·0

To summarise, of 34 lines in the nebular spectrum, 17, including the strongest, have been arranged in suspected band groups. Without additional evidence, however, no conclusion can be safely drawn as to the reality of these groups. While the numerical agreements are not unsatisfactory, it is far from impossible that such coincidences are fortuitous. Confirmation would be lent to this scheme if new lines could be found which would fall into one or other of the above bands; exposures of nebular spectra have been made here of as long as twenty hours without, however, detecting any new lines. In the meantime, then, until further evidence is forthcoming, the reality of the above groups must remain in doubt, and the only conclusion that may be safely drawn is that there is no inherent difficulty in supposing the nebular spectrum to have its origin in a molecular carrier.

Nature of the Hypothetical Molecule.—As the general appearance of the spectrum and the separation of the suspected band lines suggest, the moment of inertia of the hypothetical molecule must be small (of the order of 2×10^{-42} gm. cm.^{2}). So small a moment of inertia clearly suggests that the atoms which constitute the molecule must be of small mass. Of the elements hydrogen, helium, carbon, and nitrogen known to exist in nebulæ, only atoms of the first two are, therefore, likely to form the hypothetical molecule. The spectra of the H_2 and He_2 molecules are already known, and there is no similarity between either of these spectra on one hand and the nebular spectrum on the other. As a working hypothesis the suggestion may therefore be made that the nebular spectrum has its origin in a H He molecule with a moment of inertia of the order of 2×10^{-42} gm. cm.^{2}, and a resultant separation of the H and He nuclei of about $0{\cdot}1 \times 10^{-8}$ cm. In view of the known chemical activity of atomic hydrogen and also of the existence of molecular helium, it is not improbable that such molecules must occasionally be formed. In fact, Aston ("Isotopes," p. 99) has suspected their existence in his positive ray experiments.

Probably the chief merit in the foregoing discussion is that it furnishes a suggestive working hypothesis for finding the nebular lines in the laboratory. The problem becomes one, not of finding new elements—a difficult matter—but of examining the spectrum of a molecule which is known to exist. While our knowledge of physical conditions in the nebulæ is still obscure, yet it may serve as a guide to experimental investigation. Clearly atomic hydrogen and helium must be present in a highly rarefied condition and presumably at low temperatures; such a condition can be duplicated probably by the introduction of some helium in the centre of a long Wood vacuum tube where atomic hydrogen is known to exist in abundant quantities. Not only must the conditions be right for the formation of the molecule, but once formed it must be excited to radiation; for a nebular absorption spectrum is not known to exist, and hence the normal hypothetical molecule must radiate in the far ultra-violet. Such difficult problems of laboratory technique must be left to others; an attempt, however, will be made here to secure further astronomical evidence on the reality or otherwise of the suspected bands.

H. H. PLASKETT.

Dominion Astrophysical Observatory,
Victoria, August 4.

Dutch Pendulum Observations in Submarines.

THREE submarines of the Dutch Royal Navy with the mother-ship *Pelikaan* are about to sail for Java. At the request of the Dutch Geodetical Committee (Rijkscommissie voor Graadmeting en Waterpassing), his Excellency the Minister of Marine has allowed Dr. F. A. Vening Meinesz, engineer appointed to the Committee, to join one of the submarines for the purpose of making pendulum observations on board during the voyage.

For several years Dr. Vening Meinesz has been engaged in determining the intensity of gravity at 51 stations in the Netherlands. The difficulties caused by the extreme mobility of the soil in part of the country induced him to work out a method for the elimination of the resulting disturbances; this has been applied with complete success, as will be shown in a publication—in French—to appear shortly. It was hoped that the extended theory might be applied to pendulum observations on board an ocean steamer. A first trial, however, on a steamer of the Koninklijke Paketvaart Maatschappij from Ymuiden to Flushing failed through the very turbulent sea.

In the spring of this year, Dr. Vening Meinesz gave a short exposition of his theory at the Physical and Medical Congress at Maastricht. Prof. F. K. Th. van Itterson, director of the Government mines at Heerlen, suggested that the observations might be successfully carried out on board a submerged submarine, where the disturbances could be expected to be less than on the surface of the sea. His opinion was found to be correct at a trial on board a submarine at the Helder. Notwithstanding the fact that a heavy gale was blowing and the sea was very rough, the movements of the ship, submerged at a depth of 15 metres, were so trifling that the amplitude of the pendulums, which were hanging quietly at first, amounted to no more than 8′-12′ after a quarter of an hour.

A brief exposition of the theory as given by Dr. Vening Meinesz at the Congress at Maastricht and published in *de Ingenieur*, 1923, No. 18, may be of interest.

The influence of the horizontal and vertical movements of the ship may be eliminated by the use of two pairs of pendulums swinging together from the same support, the two pairs moving in two planes. In the Von Sterneck apparatus used by Dr. Vening Meinesz, these two planes are at right angles to each other. The movements of each pendulum are to be photographically recorded.

The equation of movement of a pendulum is

$$\frac{g}{l}\theta+\theta''+\mathrm{D}=0,$$

θ being the angle of inclination and l the length of the pendulum, D a term introduced by the disturbances.

Putting $$\frac{g}{l}=n^2$$

and introducing the complex variable

$$q=\theta-\frac{i}{n}\theta',$$

which may be represented by a vector, the projection of which on the real axis is the angle of inclination θ, the equation assumes the form

$$q'=inq+i\frac{\mathrm{D}}{n},$$

and after integration

$$q=(q_0+\Delta^t q)e^{int}, \quad . \quad . \quad . \quad . \quad (1)$$

where $$\Delta^t q=\frac{i}{n}\int_0^t \mathrm{D}e^{-int}dt.$$

If $\mathrm{D}=0$, the constant vector q_0 is rotating with a constant velocity n.

If $\mathrm{D}\neq 0$, q varies by the quantity $\Delta^t q$ in the time t. The change which the term D causes in the amplitude, *i.e.* the length $q_0+\Delta^t q$, and in the period of the oscillation, *i.e.* the time in which $q_0+\Delta^t q$ describes the angle π, may be readily inferred from Fig. 1.

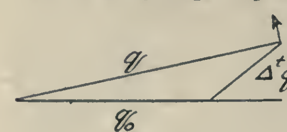

FIG. 1.

Equation (1) enables us to investigate the influence of the different causes of disturbance.

(1) *Horizontal Movements.*—If the acceleration of the horizontal movement is y'', we have $\mathrm{D}=y''/l$; using two pendulums with equal values for n and y'' and swinging in the same plane, the value of $\Delta^t q$ is the same for both; hence the difference of the oscillation vectors is constant. This constant vector may thus be considered as the oscillation vector of an undisturbed pendulum having the same period of oscillation. The angle of inclination of this hypothetical pendulum is equal to the difference between the angles of inclination of the two real pendulums.

Each pair of pendulums of the apparatus may thus be substituted by a hypothetical pendulum free from the disturbances caused by horizontal movements.

(2) *Vertical Movements.*—The influence of the vertical movements is less than that of the horizontal. On the other hand, it is impossible to eliminate it entirely. Since the vertical acceleration is indissolubly connected with the acceleration of gravity, it is obvious that elimination of the former would imply elimination of the latter.

From the following reasoning it appears, however, that we are able to eliminate the influence which depends on the phase of the pendulum, so that the result is only affected by the mean vertical acceleration. Expressing the vertical acceleration by y'', then we have $\mathrm{D}=(x''/l)\theta$. If we divide the equation of movement by q:

$$\frac{q'}{q}=in+\frac{in}{g}x''\frac{\theta}{q},$$

and represent the phase of the pendulum by ϕ,

$$\theta=a\cos\phi \text{ and } q=ae^{i\phi},$$

where a is the amplitude; thus

$$\frac{\theta}{q}=\tfrac{1}{2}+\tfrac{1}{2}e^{-2i\phi},$$

the equation may be written:

$$\frac{q'}{q}=in+\frac{in}{2g}x''+\frac{in}{2g}x''e^{-2i\phi}.$$

Each hypothetical pendulum corresponding with a pair of pendulums of the apparatus gives a similar equation; the two may be distinguished one from the other by the suffixes 1 and 2. The following relation is easily derived:

$$in+\frac{in}{2g}x''=\frac{(q_1'/q')-(q_2'/q_2)e^{2i(\phi_2-\phi_1)}}{1-e^{2i(\phi_2-\phi_1)}}.$$

Passing to real quantities and putting the ratio of the amplitudes $a_2/a_1=p$, we get

$$n+\frac{n}{2g}x''=\frac{\phi_1'+\phi_2'}{2}-\tfrac{1}{2}\frac{p'}{p}\cot(\phi_2-\phi_1).$$

For the right-hand member of this equation the observations yield a mean value; the first term is the mean velocity of the phase.

For the computation of n it is necessary to know the mean value of x'' during the time between the observations; obviously we may take for this value

$$\frac{1}{t}(x'_{\text{end}}-x'_{\text{beginning}}).$$

If the beginning and the end of the observations coincide with the moments when the vertical velocity of the support may be supposed to be 0, the same is true for the mean value of x''. These moments cannot be accurately ascertained, but we may take the moments when the vertical movement changes its direction. The resulting error can be reduced *ad libitum* by extending the duration of the observations.

In this way the horizontal as well as the vertical movements of the support may be eliminated. The influence of the inclination of the support can also be taken into account. In order to obtain the required accuracy, however, it should not be allowed to exceed 1° in either direction.

J. J. A. MULLER,
Member of the Dutch Geod. Comm.
Zeist, August 18.

Long-range Particles from Radium-active Deposit.

WHILE studying the H-particles found by Sir Ernest Rutherford to be the first disintegration product of aluminium and some other atoms, under α-bombardment, we have developed a new method for obtaining strong and practically constant sources of such radiation. The method consists in enclosing dry radium emanation mixed with pure oxygen within thin-walled capillaries of hard (potassium) glass, lined with some $12\,\mu$ thickness of aluminium foil pressing well against the glass. As a small number of long-range particles were given off from the glass itself, we have also made use of capillaries drawn out from tubes of pure silica.

Some of the elements not previously investigated for H-particles have been examined in this manner by the scintillation method, the results proving that scandium, vanadium, cobalt, arsenic, and indium—the three first as oxides, the last two as metallic mirror and as chloride respectively—do not give off long-range particles (>30 cm. of air) to a greater number than 3 or 4 times $\mathrm{N}.10^{-8}$, where N is the number of α-particles from radium C discharged

per second within the capillary. A very small number of such particles were actually observed with most of these substances, the scintillations being, however, too few for anything definite to be said at present regarding their origin.

Having regarded quartz as an ideal non-active substance to be used in these experiments, we were somewhat disappointed at finding, with a more thin-walled capillary than the others, a relatively large number of faint but distinct scintillations from the unlined part of the quartz, the rest of the capillary, lined with a thin coating of scandium oxide, giving no such scintillations. These scintillations practically disappeared when the total absorption was raised from 10 to 15 cm. by interposition of a mica filter. Similar results were afterwards obtained with other thin-walled capillaries; the absorption curve for the H-particles is being at present more accurately determined in this Institute.

Considering the high purity of the quartz, and the care taken to free the emanation from moisture and other hydrogen contaminations, we see no other way to explain this observation than by assuming silicon to give off H-particles of the maximal range just stated.

We have recently constructed a different emanation vessel in which the substances to be examined are spread in thin layers over copper foil of about 4 cm. absorbing power, forming the bottom of a narrow emanation trough, the emergent H-particles being counted from below with a scintilloscope. In this manner we have obtained fairly conclusive evidence that H-particles are also given off from the following elements :

Silicon, as element, approximate maximal range 18 cm. air.
Beryllium, as oxide, approximate maximal range 12 cm. air.
Magnesium, as oxide, approximate maximal range 13 cm. air.
Lithium, as carbonate, approximate maximal range 10 cm. air.

With lithium the results are less definite than with the others, mainly owing to the difficulty of excluding contamination with hydrogen compounds.

Blank experiments with only the bare copper foil (which had previously been bombarded with cathode rays in a vacuum to remove occluded gases) showed a much smaller number of H-particles. and, judging from the absorption curve, due to "neutral" H-particles. We are having the apparatus reconstructed so as to eliminate errors from this source.

A more detailed description of our experimental arrangement is being published shortly. The emanation capillaries will be used in this Institute also for studying atomic disintegration by the Wilson method.

Our results seem so far to indicate that the hydrogen nucleus is a more common constituent of the lighter atoms than one has hitherto been inclined to believe.

GERHARD KIRSCH.
HANS PETTERSSON.
Institut für Radiumforschung, Wien.

The Menace to Civilisation: an Appeal to Men of Science.

MAY I ask the hospitality of the columns of NATURE for an appeal to men of science throughout the world ?

The enthusiastic pioneers of Victorian times, whose work underlies the fabric of modern science, always thought of themselves as beneficent agents. In them scientific ardour was joined with devotion to the welfare of humanity. They saw science releasing men from toil, improving their health and comfort, spreading toleration and promoting international understanding. Some part of these hopes has been realised, while others we may yet hope to realise.

But we are now faced with pressing and imminent dangers which the Victorians could not foresee. Science has immensely increased the destructive powers of mankind, without in the least diminishing their readiness to use those powers. It has been stated by a member of the Government that since the Armistice, "in the different civilised countries" no less than five kinds of poison gas have been invented, each more deadly than any used in the War. This sentence is not quoted to illustrate the conception of civilisation current among politicians, but merely to indicate the present tendency of research in one direction to amplify the means of destruction which will be available in the next war. At any moment a caprice of politics, or a vicissitude of international trade, may plunge us into a war which we shall be quite unable to prevent. In that war, which every year's delay will make the more deadly, the most incredible powers of destroying not only human life, but the whole apparatus of our civilisation, will be entrusted to boys of eighteen, and, for all we know, to African negroes. Science will have crushed the civilisation that gave it birth.

If the forces now at work are allowed free play this result may reasonably be regarded as not only a probability, but also a practical certainty ; quite as certain, for example, as was the French Revolution when Lord Chesterfield prophesied its coming. Whether the storm will burst on us or on our grandchildren we cannot tell, but that the heavens are big with it is plain to see. The really desperate part of the position is that, so far as Europe goes, the total collapse of all that we have learnt to know as civilised life is regarded with almost complete indifference. Each nation is on a par with the man in Æsop, whose only care, when the ship was sinking, was to take up such a position that he could have the pleasure of seeing his enemy perish before he succumbed himself. So long as we have an Air Force which can destroy the other people's capital at least as soon as they destroy ours, we are quite happy, so far as Parliament and the Press are concerned, at any rate.

Is it too much to hope for something better from men and women who have had a scientific training, who have learnt in their work the essential fellowship of all servants of science, and whose consciences must tell them that it is their efforts, in whatever spirit they may have been conceived, which are now in danger of being directly responsible for the most appalling disaster in human history ? It is not necessary to speak of the terror-stricken multitudes in the doomed cities, the screams of women and children in helpless anguish, the tragedy of Pompeii repeated on a thousand-fold scale ; nor does it take much imagination to foresee the red ruin and breaking up of laws that will follow : can any one think that a world that has suffered such unimaginable horrors from science will hereafter tolerate it in the hope that it may do something to alleviate cancer ? In destroying civilisation, science will also destroy itself.

The only hope for the world lies in the men of science. It is their paramount duty to see that the knowledge they win is used only for the good of their race and not for its destruction. The day is past when they can simply throw their discoveries out into the world and let them take their chance. In my opinion the only possible salvation lies in the immediate formation of an international league of men and women of science who shall pledge themselves not only to fight against war, but to refuse to

give their assistance in any scientific capacity in the event of war coming despite their efforts to prevent it. Without trained technical assistance the warfare of the future will be impossible. If they wish to carry a rifle, by all means let them: they will not do much harm with a rifle. But a refusal to give their technical assistance would not only bring any war to a standstill, but would also be the strongest possible guarantee against it breaking out. If this measure is not taken, and promptly, we may well fear that the new order that rises from the ruins of the old will persecute science as whole-heartedly as ever did the rulers of the Middle Ages, and with better reason.

W. D. EVANS.

68 Argyle Road, West Ealing,
London, W.13.

The Heisenberg Theory of the Anomalous Zeeman Effect.

IN his theory for doublets Heisenberg (*Zeit. f. Physik*, 8, 273, 1922) assumes that the atom may be looked at as made of two parts: (1) the shell and (2) the valence electron. Expressing angular momenta in multiples of $h/2\pi$ and choosing the direction of the angular momentum of the shell as positive, the electron is allowed to have angular momenta $I=\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{5}{2}, \ldots$ in the $s, p, d, \ldots$ states respectively, and the shell has in all of the states the angular momentum $\frac{1}{2}$. The observed Zeeman patterns show that $I=\frac{3}{2}$ in $2p_1$ and $I=-\frac{3}{2}$ in $2p_2$. The observed energy levels show that the energy in $2p_1$ is higher than in $2p_2$. The writer experienced the following difficulty in accounting for this relative position of energy levels.

Various hypotheses can be made as to the nature of the interaction between the shell and the electron. We may suppose, for example, that the magnetic field of the electron induces a precession in the shell in a manner analogous to that in which an external magnetic field induces a precession in the electronic orbit. We then suppose, too, that the field due to the shell produces a precession of the electron. The contribution to the kinetic energy of each of these precessions is $-\mu H \cos \vartheta$, where μ, H, ϑ are respectively the magnetic moment of the shell, the field at the shell due to the electron, and the angle between the positive directions of μ and H. The contribution of both is $-2\mu H \cos\vartheta$. The mutual energy of the magnetic fields is $+\mu H \cos\vartheta$. There is no contribution to the energy of the electric field because the radius of the orbits is unchanged (Sommerfeld, "Atombau und Spektrallinien," third edition, p. 380). The energy to be added to that coming from other sources is then $-\mu H \cos\vartheta$. On this hypothesis, therefore, the $2p_1$ state has the lower energy, while the reverse is actually the case.

If there were no induced precession in the shell, but if the electronic precession should be still hypothesised, the $2p_1$ and the $2p_2$ levels would coincide.

If the shell and the electron should be supposed to have no induced precession, the energy of the magnetic field becomes the only source for the energy of separation of the $2p_2$ levels. This energy is $+\mu H \cos\vartheta$ and thus makes the $2p_1$ level the state of higher energy, as it is actually observed to be.

It seems questionable, however, whether the hypothesis just made can be maintained, for it presupposes that the dimensions of the orbits of the valence and the shell electrons are the same in the $2p_1$ and the $2p_2$ state. This may be contrary to quantum conditions if the energy of the magnetic field is considered as kinetic energy. If two electrons should be constrained to move on the opposite ends of a diameter of a circle of variable radius (as in Bohr's first helium model), the kinetic energy becomes of the form:

$$\frac{m_1 v_1^2}{2} + \frac{m_2 v_2^2}{2} + M_{12} v_1 v_2 = (m_1 + M_{12}) v_1^2,$$

where m_1, m_2, v_1, v_2 are respectively the masses and velocities of the electrons and $M_{12}v_1v_2$ is the mutual energy of their magnetic fields. The case is formally analogous to the hydrogen atom, and a substitution in well-known formulas shows that the total energy becomes decreased if M_{12} is increased. The reason for this is traceable to a decrease in the radius of the orbit. Thus again the effect on the $2p_1$ level is opposite to that observed.

The matter of the sign of the energy in the doublet terms thus does not appear to the writer to be sufficiently clear.

The same question of sign is present in the case of triplet terms. In addition to this the $2p_2$ term of triplets does not seem to be accounted for properly by Heisenberg. His arrangement of angular momenta accounts for the energy level of the $2p_2$ state. I obtain, however, a different result for the Zeeman resolution. On going through Heisenberg's calculation his lines 5, 6, counted from the bottom of page 292 and leading to the equation $\cos\theta = m/p_{12}$ do not appear obvious. His p_{12} is the projection of a vector in the direction J, m is the projection of the same vector in the direction H, and θ is the angle between J and H. The above equation is then $\cos(JH) = \cos(AH)/\cos(AJ)$, which does not appear to be generally valid. It becomes correct, however, if A and J are the same. They are the same for doublets and for the $2p_1$, $2p_3$ terms of triplets, but not for the $2p_2$ term.

G. BREIT
(National Research Fellow).
The University of Minnesota,
Minneapolis, U.S.A.

Thunderstorms and Ozone.

THE question—What chemical changes, if any, are associated with atmospheric electrical discharges?—does not appear hitherto to have received a definite answer. Nitrogen peroxide and ozone are both referred to in scientific literature, although neither appears to have been satisfactorily identified, and their presence has been perhaps inferred from the phenomena observed while "sparking" air by artificial means.

No reliance can be placed upon observations made with guaiacum or starch-potassium iodide papers, and the work of the more serious investigators on ozone in the air (Pring, Proc. Roy. Soc., 1914, 90a, 204; Hayhurst and Pring, Jour. Chem. Soc., 1910, 868; Kaiser and McMaster, *Am. Chem.*, July 1, 1908, 39, 96; Henriet and Bonissy, *Comp. rend.*, 1908, 146, 977; and the older work of Houzeau, Schöne, H. de Varigny, Hached and Arny, and Thierry) has thrown no light on this subject.

Unexpectedly clear evidence on the above point was obtained by me in connexion with the severe thunderstorm which passed over the metropolis from south to north, during the early hours of July 10 last. The lightning on this occasion was generally described in the London press as the most vivid and prolonged display in living memory (*vide* NATURE, July 21, p. 113).

I have for some time been measuring the proportion of certain variable gaseous constituents in London and country air, and succeeded last spring in working out an improved method of estimating ozone, in

which inaccuracies in the potassium iodide method of estimation, namely, the interference of sulphur dioxide and serious loss of iodine by volatilisation, were overcome by first removing the former, and then allowing the ozonised air to react on potassium iodide in the presence of a known volume of N/100 thiosulphate solution, which fixes the liberated iodine. The apparatus used will be described later, together with the general results.

The measurements form two series, determinations of the sulphur dioxide and nitrogen peroxide in dilute sodium bicarbonate, alternating with those of ozone, sulphur dioxide, and ammonia. Each test proceeds for about three days, and is conducted in duplicate at the village of Upminster, Essex (17 miles E.N.E. of Charing Cross), and at Messrs. Jeyes' laboratory, Plaistow, E., 5000-10,000 litres of the outside air in each case being examined. The former estimation was in progress during the storm at both places. Upminster lay on the eastern fringe of the storm track. It experienced severe lightning, but only 0·36 inches of rain fell there, as against 2 inches at the London station, which was nearer the centre. The proportion of nitrogen peroxide before, during, and after the storm (recorded in terms of 1 volume of NO_2 in . . . million volumes of air) was as follows :—

	Before.	During.	Since.
London	1 in 120 millions.	1 in 114 millions.	1 in 134 millions.
Upminster . .	1 in 350 millions.	1 in 440 millions.	1 in 400 millions.

There was, therefore, no appreciable increase in nitrogen peroxide in the air during the storm. The sulphur dioxide and ammonia remained practically constant during the above period, the proportion of the former being—London, 1 in 20 millions, Upminster, 1 in 45 millions, while the ammonia amounted to 1 in 200 millions in both.

This result has been confirmed by an examination of rain water. I have not yet collected during a thunderstorm a specimen of London rain sufficiently free from suspended particles (which completely mask its analysis) to be trustworthy; but in a bright sample collected during a thunderstorm at Upminster, the nitric acid content proved to be equivalent to a N/200,000 nitric acid solution, which is slightly under the average of several samples collected during still conditions.

The proportion of ozone present a few days before the storm was 1 in 23 millions in London, and 1 in 22 millions at Upminster, but the average amount present between July 13 and 16 was 1 in 3·2 millions in London, and 1 in 14·8 millions in the country. *There was, therefore, more than seven times the previous quantity of ozone present in London air three to six days after the storm,* and the proportion must have been appreciably higher than this at the time, owing to the subsequent loss by diffusion and convection, and to the change into oxygen, which can be readily proved to occur. A fortnight later the proportion of ozone at both places was 1 in 18·5 millions.

Confirmation of the above results has been obtained during a much less spectacular thunderstorm, which visited both stations about midday on August 24 last. A few days previously the proportion of ozone found was—London, 1 in 22·7 millions, Upminster, 1 in 18·8 millions. Measurements of the ozone had been in progress nearly twenty-four hours when the storm occurred, and were continued for the next three days. The average content for the four days was—London, 1 in 9·71 millions, Upminster, 1 in 7·8 millions, *the proportion of ozone having thus been more than doubled in each instance.*

I hope to devise a portable modification of the apparatus that will enable estimations to be completed in two or three hours, in which case much more detailed information on the subject will be obtained than is possible in three- to four-day averages.

WILLIAM C. REYNOLDS.

"Wharfedale," Upminster, Essex,
August 28.

A Method for Demonstrating the Stages in the Life History of Monocystis in Practical Class Work.

IN the text-books on practical zoology in common use in zoological laboratories, the method advocated for making preparations of the contents of the vesiculæ seminales of the earthworm for the examination of the stages in the life history of Monocystis is what is usually known as the cover-glass method (*vide* Marshall and Hurst, "Practical Zoology," 9th edition, p. 13). It is, I believe, a matter of common experience that, when this method is adopted, only a small percentage of the students succeed in finding in their own preparations all, or even the majority, of the important stages. Generally only the trophozoite and sporocyst stages are found, and demonstration specimens have to be resorted to to fill in the gaps.

This repeated failure in previous years suggested the trial of a modification of the method, and the result may be of interest to those who have charge of practical classes. The preliminaries are the same. The vesiculæ seminales (preferably the posterior lateral vesiculæ seminales, as these appear to contain more specimens) are removed from a freshly killed (with chloroform) worm, and placed in a watch-glass with about five to six times their bulk of normal salt solution. The material is teased thoroughly with needles. A drop of the fluid and particularly a portion of the teased wall of the vesicula seminalis is placed on a slide and, if desired, faintly stained with Dahlia. Cover with a cover-glass, and the preparation is ready for examination. If the operation has been rapid and the staining only slight, the trophozoites will be found to be still alive and exhibiting the characteristic gregarine movement. The encysted stages will be found embedded in the tissue of the wall of the vesicula seminalis, and it is for this reason that stress should be laid upon the inclusion of a portion of the wall in the preparation. In this situation the stages which are not usually found, *i.e.* the gametocytes in association, and more rarely gametocytes showing fragmentation into gametes, occur, as well as large numbers of sporocysts containing spores.

Below is a summary of the results (as recorded by the students themselves) obtained with a class of twenty students, one worm serving for every two students. The class was held in May.

Stages.	Percentage of Students obtaining Stages.
Trophozoite	85
Gametocytes in association . .	60
Gametocytes showing fragmentation into gametes	25
Sporocysts with spores . . .	95

As experience shows, worms vary considerably in the extent to which they are infested with Monocystis, but the above result may be taken as representative.

It may be of interest also to record that the worms used by the class had been kept in the laboratory from the previous November. The method adopted was to keep them in a tank in a compost made up of one third earth and two-thirds moist leaf-mould. The compost must be kept reasonably moist, and it was found advantageous to change it about every three weeks.

A. J. GROVE.

Zoological Laboratory,
The University, Sheffield,
August 21.

The British Association at Liverpool.

Sir Ernest Rutherford, F.R.S.

The ninety-first annual meeting of the British Association for the Advancement of Science opened on Wednesday evening with a brilliant address by the president, Sir Ernest Rutherford, on the electrical structure of matter—a subject to which he has made many notable contributions and on which he is a leading exponent. He is, we believe, the youngest president appointed by the Council since the foundation of the Association in 1831. The average age of the presidents of the Association is nearly sixty-two years; and until this year the youngest presidents were Sir Arthur Rucker, Sir Joseph Thomson, and Dr. Bateson, each of whom was fifty-three years of age when holding the office.

Sir Ernest Rutherford was born at Nelson, New Zealand, on August 30, 1871, and, after graduating in the University of New Zealand, proceeded with an 1851 Exhibition Science Scholarship to Trinity College, Cambridge, where he at once took up research at the Cavendish Laboratory, leading in 1897 to a research degree and the Coutts-Trotter Scholarship. In the following year, and on the advice of Sir Joseph Thomson, he was appointed Macdonald professor of physics in McGill University, Montreal, where he remained until 1907 and continued with such remarkable success the studies of the properties of radioactive substances in which he had shown great originality and insight at Cambridge. It was while he was at Montreal that Sir Ernest Rutherford was joined by Prof. Soddy from Oxford, and together they proved by experimental evidence that radioactivity is an atomic phenomenon accompanied by chemical changes in which new types of matter are produced, that the changes must occur within the atom, and that the radioactive substances must be undergoing transformation. It was twenty-one years ago when this theory of the cause and nature of radioactivity was published in the *Philosophical Magazine*, and the advances in atomic physics and chemistry since then have been both startling and stimulating. The distinguishing characteristic of Sir Ernest Rutherford's work has always been extreme care in verifying every step by thorough experimental test, and it is on this account that a theory which at first provoked much adverse criticism has become an established scientific principle.

[*Photo: Russell and Sons, London.*

The work done by Sir Ernest Rutherford at Montreal, though so novel and suggestive, represented only the first harvest in a field which has been growing in extent and increasing in fertility ever since. While Langworthy professor of physics in the University of Manchester from 1907 to 1919, and as Cavendish professor of physics in the University of Cambridge during the past four years, he and his pupils have cultivated this field with astonishing success. Attention has been given particularly to the α-particle, which is liberated spontaneously in radioactive transformations and has proved of special service in elucidating the structure of the atom. Bombardment of the lighter elements, particularly of nitrogen and aluminium, by these swift projectiles, has disclosed the presence of hydrogen nuclei within the nuclei of some of these elements, and this work has played an important part in modern theories of the structure of matter, with which Sir Ernest Rutherford deals in his presidential address, reproduced in this week's Supplement to Nature.

Arrangements for the Meeting.

The meeting of the British Association now being held in Liverpool is of particular importance, both by reason of the large attendance and through the weighty scientific matters under discussion. In other respects also it is noteworthy, on account of departure from what are traditional habits of the Association.

The president's address in the Philharmonic Hall was not a mere reading of written matter. The

printed address was available as usual, but was given as a discourse illustrated by lantern slides and models. The address was broadcasted, and was reproduced in another hall in the city at an overflow meeting: being thus communicated to a wider audience than has ever previously been the case. No better example of the advancement of science in the Association could be made.

The Sectional programmes are extraordinarily full and exhibit an increasing tendency towards afternoon lectures as well as more numerous meetings on the last morning, September 19. At the same time the great increase in both general and sectional excursions and visits to works is loading the programme to an extent which must satisfy even the most thirsty for scientific knowledge. The Local Committee has spared no trouble to make these excursions and visits to works a success. There are about fifty-five of them, and a brief account of what visitors can see in each is contained in a dainty excursion guide, a copy of which is given to each member. Apart from its utility at the moment, this little book forms a useful companion volume to the handbook "Merseyside."

The scientific exhibition at the Central Technical School, and the soiree at the University, represent together a great development of the small sectional and other exhibits which have been a feature of many meetings. They attempt to show all that is latest in science, in apparatus, experiment, etc., and at the same time, through lecturettes and cinema exhibitions, to present much new matter in a form of more general interest than papers in the Sections addressed to specialists only. While the latter arouse the interest of the philosopher, the former seek to promote general interest in science and its application. The organisation of this exhibition and soiree has represented an enormous amount of work.

It had originally been decided to have no arrangements for the evening of Monday, September 17, but it was felt that many visiting members would like some recreation, so the Local Committee has taken several hundred seats at the Playhouse, when the Liverpool Repertory Theatre Co. will present two plays. Application for tickets, which will be free, must be made in the Reception Room, and seats will be allocated in order of application.

On Sunday morning, September 16, special services will be held in many places of worship, and Canon Barnes will preach and the Lord Mayor attend in state the service at the Lady Chapel of the Liverpool Cathedral. In the afternoon of the same day there will be an organ recital in the Great Hall at St. George's Hall.

An outstanding feature of the meeting is the number of foreign and colonial visitors. Representative men of science from Norway, Sweden, Denmark, Holland, Switzerland, France, Italy, Hungary, United States and Canada are present, as well as a representative from India.

This reunion of scientific workers from so many parts of the globe cannot but be to the advantage of science as a whole, and indirectly help the international nature of science. There seems something peculiarly suitable that such a notable gathering should be held in Liverpool, our most cosmopolitan city and port.

Probably for the first time in its history the housing question has directly touched the Association. The question of accommodation has been a very difficult one for the Local Committee, as at the present time there are practically no vacant rooms even in so large a city. Fortunately Southport, which is quite near, and has an excellent train service to Liverpool, possesses several excellent hotels, and weekly railway tickets at reduced fares are available.

Though most of the Sectional meetings are being held in the University Buildings, Sections E, F, and H meet in the city in the near neighbourhood of the Reception Room. For the general convenience of members, lunch is provided in the Students' Union and in a marquee at the University, and also in St. George's Hall alongside and opening out of the Reception Room.

Through the kindness of the Tramways Committee of the Corporation members are allowed to travel free on tramcars on showing their Association badge.

The members attending the meeting are thus enjoying a busy and profitable week. ALFRED HOLT.

The Japanese Earthquake of September 1.

By DR. CHARLES DAVISON.

SINCE November 4, 1854, the Empire of Japan has experienced no earthquake, not even in 1891, that can be compared in strength and destructiveness with that which occurred about noon on September 1. Semi-destructive shocks, or shocks capable of throwing down chimneys and stone-lamps, are not uncommon in the district round Tokyo and Yokohama, the most notable during recent years being those of February 22, 1880, June 20, 1894, December 8, 1921, and April 26, 1922. The first of these shocks is of interest as it led to an event in the history of seismology, the foundation by Prof. Milne of the Seismological Society of Japan. But the continued existence of the capital and seaport points to their long-standing immunity from destructive earthquakes, though, as they lie close to a well-known seismic zone, it may be for that very reason that this last great movement occurred in their immediate neighbourhood.

How great the disaster is we do not yet know. As usual in an earthquake of this magnitude, railway-lines are crumpled, telegraphs and telephones are destroyed, and our chief news comes, for the first time on such an occasion, by wireless. It is uncertain, too, how much of the destruction was due directly to the earthquake, how much to the fires that broke out immediately and spread at first unchecked owing to the derangement of the water-mains, and how much to the sea-waves that followed. In Yokohama, the earthquake was mainly responsible, for it left little standing for fires to work upon. In Tokyo, not a house is undamaged, and about two-thirds of the city—including, it is reported, the Imperial University, the Imperial Museum, and the

Ministry of Education—are destroyed. The most serious loss is that of the lofty steel-brick buildings recently erected. It was supposed that they would resist a shock of the utmost violence, and if their destruction was, as is probable, due to the earthquake and not to the fire, it may be necessary to prohibit their erection in the future, and this will greatly restrict the manufacturing power of the country. Estimates of the total loss of life vary widely. Some place it as high as half a million, and in Tokyo inquests have already been held on more than 32,000 bodies. There can be little doubt that the work of a few minutes has been more costly in life and treasure to Japan than a great and long-continued war.

There appear to have been no fore-shocks strong enough to give warning of the first and greatest earthquake. Among the crowd of after-shocks that followed, one was strong enough to be felt at Osaka at 2.25 P.M. on September 1. Mr. J. J. Shaw at West Bromwich recorded a second earthquake at 9 A.M. on the same day (6 P.M. Japanese time). On September 2, almost exactly twenty-four hours after the principal shock, seismographs in Great Britain revealed the occurrence of another earthquake, almost as powerful as the first, with an origin at about the same distance and in nearly the same direction as the first. No mention is made of this earthquake in the Japanese reports, unless it is the shock which on the morning of September 2 is said to have destroyed 6000 houses in the town of Kawaguchi. But its origin may have been situated more to the south and possibly near the Bonin Islands.

The number of after-shocks was unusually great. According to the Tokyo Central Observatory, 1039 were recorded between noon on September 1 and 6 A.M. on September 6, the numbers being 356 on September 1 and 2, 289 on September 3, 173 on September 4, 148 on September 5, and 63 during the first quarter of September 6, the usual decline in frequency being thus manifest. In the two months following the great earthquake of 1854, the number of after-shocks actually felt was 443. During the five days after the Mino-Owari earthquake of 1891, 808 shocks were recorded at Gifu. The number of after-shocks, however, seems to depend on the magnitude of the vertical, rather than of the horizontal, displacement; and thus, the large number following the recent earthquake may imply that the movement which caused it possessed a noticeable vertical component.

Other evidence of vertical displacement at the epicentre is provided by the arrival of the sea-waves soon after the earthquake. Little is known about these waves. They appear to have swamped the reclaimed portions of Yokohama and Tokyo and to have caused much damage along the numerous creeks and canals. Many villages along the coast of the peninsula south of Yokohama were washed away. The naval base at Yokosuka (about 10 miles south of Yokohama) was destroyed, partly by the earthquake, partly by the sea-waves. There is no evidence, however, that the waves were of great height like those of the Sanriku earthquake of 1896. And it is important to notice that, of the three cables leading to Tokyo, only one was fractured by the earthquake, the others continuing to work normally.

With regard to the position of the epicentre, we have some, though not much, evidence. The earthquake was evidently stronger at Yokohama than at Tokyo, 16 miles farther north. The sea-waves may have been caused by submarine landslips, but they were probably due to a vertical displacement of the ocean-bed. That the movement at the surface, at any rate in Tokyo Bay, was not very considerable seems to be indicated by the preservation of two of the three lines of cable. The apparent lowness of the sea-waves may have been due to the smallness of the vertical movements, but it may have resulted from a restricted area of submarine displacement, such as would be provided by an epicentral area crossing land on one or both sides of Sagami Bay, the inlet leading up to Tokyo Bay. Not much trust can be placed on the reported disappearance of the island of Oshima, which seems to be near the epicentral district, but it may have taken part in a general movement of subsidence and thus be of diminished area.

For our knowledge of the earthquakes of the Tokyo district, we are chiefly indebted to the labours of Prof. Omori. In two recent numbers of *Seismological Notes* (No. 2, 1922, pp. 1-21, and No. 3, 1922, pp. 1-30) he has described the semi-destructive earthquakes of December 8, 1921, and April 26, 1922, and the distribution of earthquake-origins in the neighbourhood of Tokyo. A glance at the map of Japan will show that the inlet consisting of Sagami Bay and Tokyo Bay runs in a northerly direction up to Tokyo, the entrance to the latter bay being known as the Uraga channel. On the west side, the inlet is bounded by the Sagami-Izu peninsula, and on the east side, by the Awa-Kazusa peninsula. During the eight years 1914–1921, 199 earthquakes originated in the country round Tokyo, and, with few exceptions, in four seismic zones, one off the east coast of the Main Island, the second in the neighbourhood of Mount Tsukuba about forty miles north-east of Tokyo, the third in and near the Awa-Kazusa peninsula, and the fourth round Hakone at the northern end of the Sagami-Izu peninsula. In other words, during these years, the immediate neighbourhood of Tokyo was seismically quiet, while the three mountainous regions surrounding the city at a distance of about forty miles, gave rise to "very frequent occurrences of earthquakes, which, though often sharply felt in the city, are harmless, as the districts in question do not belong to a great seismic zone." Then follows this remarkable prediction. "In the course of time, however, the seismic districts" referred to above "will become gradually quiet, while the Musashi plain and the Tokyo bay may, as a compensation, recommence its seismic activity, and may result in the production of a strong earthquake, probably just after a year of marked minimum of seismic frequency."

The last strong earthquake (that of April 26, 1922) originated, according to Prof. Omori, off the west coast of the province of Awa in the Uraga channel; and, he concludes, "the Awa-Kazusa peninsula and the Sagami earthquake regions, at present so active, form obviously one continuous system separated by the Uraga channel of small seismic frequency, and it was exactly at the latter locality that the . . . strong earthquake [of April 26, 1922] took place. It seems

natural that a district like the Awa-Kazusa peninsula, where small shocks are taking place so frequently, does not give rise to a destructive earthquake; while a neighbouring region like the Uraga channel, which belongs to the same seismic zone, but is subject for the time to a low seismic frequency, may become the source of a strong shock." So far as the evidence at our disposal will allow us to judge, it seems to me very probable that the recent earthquake originated in the Uraga channel portion of this seismic zone and at a great depth—perhaps from 20 to 30 miles or more—below the surface.

Current Topics and Events.

Several matters of interest are referred to in the report of the Council of the British Association presented at the Liverpool meeting now in session. Major-General Sir David Bruce has been unanimously nominated by the Council to fill the office of president of the Association for the year 1924–25 (Toronto Meeting). The grateful thanks of the Association has been expressed by the Council to Sir Robert Hadfield for his generous gift designed to enable necessitous students to obtain scientific books. The gift is of 50*l.* in each of three years, and that sum, for the first year, has been distributed in grants of 10*l.* to each of five universities or colleges selected by lot, namely, University College of Bangor, North Wales; University College, Cardiff; Universities of Leeds, Liverpool, and Manchester. The Council, on behalf of the Association, joined in protesting against proposed changes in the Egyptian laws relating to antiquities, and received, through the Foreign Office and the High Commissioner, the assurance that the Egyptian Government would not modify the existing law without further careful consideration of protests received. The third grant of 250*l.* from the Caird Gift for research in radioactivity (for the year ending March 24, 1924) has been made to Prof. F. Soddy. In conformity with the rules, the Council has nominated the following new members to fill vacancies caused by retirement: Prof. W. Dalby, Dr. J. S. Flett, and Mr. C. T. Heycock, leaving two vacancies to be filled by the General Committee. The Council has nominated M. le Comte de St. Périer to be an honorary corresponding member of the Association. Arrangements for the meeting in Toronto, 1924, are in progress, and the Council has appointed a committee to assist the General Officers in this matter, including Sir D. Bruce, Sir Richard Gregory, Sir William Herdman, Prof. A. W. Kirkaldy, Prof. J. C. McLennan, Sir Ernest Rutherford, Sir Charles Sherrington, and Prof. A. Smithells. The General Committee at Hull desired the Council to consider the possibility of a meeting being held in England in 1924, following and supplementary to the Toronto Meeting. The Council does not, however, see the way clear for carrying out the suggestion.

In an article on the magnetic work carried out at the Royal Observatory, Greenwich, which appeared in Nature of September 1, p. 345, reference was made to the need for the removal of the recording instruments from Greenwich. The proposal to electrify railway routes in the vicinity of the observatory rendered this course necessary, and a site on the lower slopes of Holmbury Hill, Surrey, was chosen as meeting the requirements for the new station. Considerable opposition to the scheme was aroused on the plea that the site was on common land and that the necessary buildings would deface one of the best known view-points in Surrey. We now understand from Mr. L. W. Chubb, secretary of the Commons and Footpaths Preservation Society, that an alternative site has been found near Abinger Bottom, 1½ miles from Holmbury Hill. The position is on private land and is protected from interference by building operations by Abinger and Wotton commons. It is only 2¾ miles from a railway, but the Astronomer Royal and the technical advisers of the Admiralty have accepted the site as meeting the needs of a permanent magnetic observatory where the records commenced in 1840 at Greenwich may be continued.

According to the Calcutta correspondent of the *Times*, a severe earthquake shock, lasting several minutes, was felt in Calcutta at 4 o'clock on the morning of September 10. The direction of the shock was from north-east to south-west and it extended over a wide area, slight damage to buildings being reported at Dacca, and from various stations in Assam. It is stated that the shock was the most severe since the great earthquake of 1897.

We regret to announce the death on August 23, at the age of forty-nine, of Dr. E. F. Bashford, the first director of the Imperial Cancer Research Fund.

Prof. Bohuslav Brauner, professor of chemistry in the Bohemian University, Prague, has been elected an honorary foreign member of the French Chemical Society.

The *Times* correspondent at Cairo reports that the Ministry of Public Works has decided to construct a special wing to the Cairo Museum, to cost 28,000*l.*, for the purpose of housing the objects taken from the tomb of Tutankhamen.

Summer Time will cease in Great Britain, and normal time will be restored, at 3 a.m. (Summer Time) in the morning of Sunday, September 16, when the clock will be put back to 2 a.m.

Dr. Raul Gautier, director of the Observatory and professor of astronomy and meteorology in the University of Geneva, has been elected an honorary member of the Washington Academy of Sciences, in recognition of his prominence in geodesy and his intimate connexion with scientific work in Washington.

Dr. C. M. Wenyon has been appointed director-in-chief of the Wellcome Bureau of Scientific Research in succession to Dr. Andrew Balfour, who has held that post for the past ten years. Dr. Wenyon was previously director of research in the Tropics at the institution.

ACCORDING to the Journal of the Washington Academy of Sciences, Dr. C. A. Browne has been appointed chief of the United States Bureau of Chemistry, in succession to Dr. C. L. Alsberg, who resigned in July 1921. Dr. Browne has for the past sixteen years been head of the New York Sugar Trade Laboratory, and previously was chief of the sugar laboratory at the Bureau of Chemistry.

THE Western Galleries of the Science Museum, South Kensington, will be closed to the public on and after Monday, September 17, for the purpose of transferring the collections illustrating astronomy, geodesy, meteorology, geology, chemistry, physics, mining and metallurgy to the new buildings of the Science Museum now in course of erection. These collections will be placed on exhibition as soon as galleries are available for their reception.

THE Research Station, Long Ashton, Bristol, will be open to visitors on Wednesday, September 26, when the experimental work in progress will be explained by members of the staff, and in addition some of the most recent types of spraying machines and cultivators will be shown in working order by representatives of leading firms. Demonstrations of tree-stump blasting will take place at 12.45 P.M. and 2.30 P.M. The Minister of Agriculture, Sir Robert Arthur Sanders, Bart., has intimated his intention of visiting the station on this occasion.

A *Northern News Service* message from Berlin dated August 21, which appears in the *Publishers' Circular* of September 1, states that at a meeting of the leading German publishers on August 21 it was resolved to suspend entirely the publication of scientific works. Those issued during the past few months have proved to be a drug on the market, as the people who constitute the reading public for this kind of books no longer have any money to purchase them. Even the public and university libraries can no longer afford to do so.

THE field experiments on the manuring of root crops conducted at Rothamsted Experimental Station, Harpenden, provide, at this time of the year, a striking series of demonstration plots to which the attention of all interested in agriculture is invited. The potato plots show the effects of various potash manures and of the addition of increasing quantities of sulphate of ammonia to a complete fertiliser; comparative trials are also in progress using new fertilisers. On the mangold plots, the value of town refuse can be compared with that of dung, while, on the swede plots, the effect of sulphate of ammonia supplementing phosphates, potash, and dung applied at sowing time can be seen. With white turnips, comparisons are being made of the relative values of different green manuring crops which have been ploughed in. The secretary of the Station will be glad to make arrangements for parties of farmers or others desirous of inspecting the plots, or arrangements can be made on arrival at Harpenden.

APPLICATIONS are invited for the post of assistant in the pathological laboratory at Harpenden of the Ministry of Agriculture and Fisheries. Applicants must possess an honours degree in science, or similar qualification, and be proficient in zoology and botany. Among the duties of the person appointed will be the investigation and inspection of living plants in connexion with trade. Forms of application are obtainable from the Secretary of the Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1. They must be returned, with copies of recent testimonials, by October 1.

THE monthly meteorological chart of the North Atlantic for September issued by the Meteorological Office, Air Ministry, gives details of marine meteorology of general interest to all navigators traversing the Atlantic. The information deals with winds and ocean currents, normal isobars for the month, and limits of ice, together with the charted positions of derelicts, the northern and southern limits of Trades, and the mean paths of cyclonic disturbances. There is much on these meteorological charts which will enable a commander or officer to obtain not only the normal weather conditions for his passage, but also to foresee, by comparison with his own observations, the unusual or exceptional weather, and being forewarned he can often take advantage of the weather changes he experiences. Much time has been spent in obtaining the valuable data exhibited and any ordinary navigator can easily master the information contained. On the back of the chart Capt. L. A. Brooke Smith, the marine superintendent of the Meteorological Office, gives a discussion of a West Indian hurricane which is traced from the Tropics on September 13 of last year to the south-west coast of the British Isles on September 26 and 27, passing south-east of Newfoundland on September 23. The storm was also dealt with in the U.S. *Monthly Weather Review* for September 1922. The discussion and storm track are given chiefly to show how wireless telegraphy may be usefully applied for ascertaining the movement of such a storm when the ship is at sea.

A PAPER entitled "Le scienze fisiche e matematiche nelle opere di Dante," by Francesco Vercelli, was published in the February number of the *Rivista Marittima*. The author endeavours to show the character of Dante's ideas on arithmetic, geometry, mechanics, cosmology, meteorology, and optical phenomena by means of numerous quotations from the Divine Comedy and the "Convivio." Some of these do not seem very conclusive as regards Dante's opinions about the phenomena of Nature, and are such as may be picked out from the writings of many poets; but the majority furnish good illustrations of the ideas prevalent at the beginning of the fourteenth century, of which Dante is an excellent exponent. Thus we find under the heading of mechanics nothing but the notions of Aristotle as to why a body set in motion through the air may continue to move after the moving force has ceased to act on it. The author thinks there are some slight indications of independent thought in the direction of the true laws of motion, but the passages quoted do not seem very

convincing. Dante's cosmological ideas are so closely interwoven with his great poem that it is easy enough to find passages which illustrate it (see Nature, vol. 107, p. 428). The author devotes more space to meteorological phenomena, which are frequently alluded to in the descriptions of the different localities of the mountain of Purgatory, but none of the quotations given are of any special interest.

Messrs. Baird and Tatlock have just issued their "Standard Catalogue of Scientific Apparatus, 1923. Vol. 1. Chemistry." The previous edition of this catalogue was published in 1914, and the outbreak of the War a few months after publication rendered it practically useless. The present edition is conceived on a larger scale than the earlier one, the volume before us—Chemistry—alone containing 954 pages as against 1283 pages of the full 1914 catalogue. Judging from this catalogue, manufacturers of chemical apparatus have fully recovered the paralysis caused by the sudden stoppage of German goods in 1914. Certain items are missing, such as German balances, but every type of balance is to be found in the list. Practically everything obtainable in 1914 can be purchased now, the only difference being that instead of the major proportion coming from Germany, most of the apparatus is manufactured in England. Prices are naturally higher than in 1914, in round figures, judging from the selection of a number of typical pieces of apparatus, about double; this may be regarded as a normal ratio, and excludes the idea of profiteering in this industry. Diligent search revealed one item—india-rubber tubing—at less than pre-War prices. Glass apparatus, now almost entirely of British manufacture, shows some price anomalies. Beakers are about 2·5 times pre-War, and heavy cast glass about three times, probably due to difficulties in manufacture; on the other hand, blown glass apparatus is generally less than double pre-War price. For example, an eight-bulb Young evaporator column is only advanced from 27*s.* to 35*s.* The catalogue has a good index, and reflects credit on the enterprise of the publishers.

The latest special catalogue of Mr. F. Edwards, 83 High Street, Marylebone, W.1, is No. 450, entitled "Americana." It gives particulars of nearly 500 second-hand books relating to Central and South America: geography and travel, books of views, history, natural history, antiquities, etc.

Our Astronomical Column.

The Total Solar Eclipse of September 10.—As we go to press (September 11) news reaches us from the Royal Observatory, Greenwich, that the solar corona was seen through slight cloud during the total solar eclipse of Monday, September 10, and that good photographs were obtained by Mr. Worthington at Lompoc, California.

Spectroscopic Parallaxes of Stars of Type B.—The *Astrophys. Journ.* for June contains a paper by W. S. Adams and A. H. Joy on this subject. Their research was quite independent of that by D. L. Edwards (Mon. Not. R.A.S., Nov. 1922) and is based simply on general spectral type, not on differences of intensity of particular lines. It has long been known that there is less dispersion of absolute magnitude for type B than for later types, and the authors adopt definite values for each spectral sub-division. The following is an abbreviated list of their adopted values:

Spectral Type.	Adopted Absolute Magnitude.	
	Diffuse Lines.	Sharp Lines.
	mag.	mag.
B_0	−3·1	−3·1
B_2	−1·5	−2·0
B_4	−0·6	−1·2
B_6	−0·3	−0·9
B_8	+0·1	−0·6
A_0	+0·9	+0·2
A_2	+1·7	+0·9

Adams and Joy prepared this list with the aid of 34 trigonometrical parallaxes and others derived from moving clusters, group motion, and various statistical methods.

A list then follows of the parallaxes of 300 stars, based on these values. Their spectral types are deduced from Mt. Wilson spectrograms. The Harvard types are given for comparison, and seldom differ by more than one step.

The later sub-divisions of type O have also been included, using H. H. Plaskett's notation of O_5, O_6, O_7, O_8, O_9 for the stars with dark lines that precede B_0 in the sequence. The results have been tested by plotting reduced proper motion against absolute magnitude. The function actually plotted is $0{\cdot}2m + \log \mu$, m being apparent magnitude and μ proper motion. The resulting graph is nearly a straight line, which is claimed as support for their adopted values. It is admitted that there are exceptional stars which their formulæ will not fit: on one hand, super-giants, such as Rigel; on the other, abnormally faint B-stars such as Boss 1517, for which Voûte found the trigonometrical parallax 0·074″, while the spectroscopic one is 0·005″. The authors hope that Mr. Edwards's method may serve to find the dispersion in parallax for each sub-type.

Their largest spectroscopic parallax is 0·069″ (Boss 2698), and their smallest 0·002″ (twelve stars of about the 6th magnitude).

Sunspot Activity.—There are signs of the beginning of the new cycle of activity. A double spot of appreciable size, followed by a train of small ones, entered the disc shortly before the end of August, and was seen near the west limb, flanked by a large facula, on September 9. It was S. Latitude 29°, and is the first high-latitude spot of considerable size in the new cycle, though some very small sporadic ones have been seen during the last year or more.

On September 9 there was a second group of similar type, but not quite so large, on the other side of the equator, which entered the disc about September 5.

The Mt. Wilson report had already noted that the activity in June was greater than for some months past, there being five days when two groups were on the disc, and one day when three groups were visible.

Research Items.

RODRICK, THE LAST OF THE VISIGOTH KINGS.—Dr. A. H. Krappe, under the title of "The Legend of Rodrick, the last of the Visigoth Kings, and the Ermumarich Cycle," has published an elaborate monograph in which he illustrates the mode in which a legend has become embedded in a tribal saga. He arrives at the source of the vast legendary current which contributed to swell the Spanish, French, Scandinavian, and German epic. It is recorded by Byzantine historians, by the Arabian compiler in southern Spain, by a German monkish chronicler, by a French jongleur, and by an Icelandic sagaman. When the epic form breaks down, the material is worked up anew in the ballads of southern and northern Europe, and while in Spain the people sing of the fatal passion of Don Rodrigo, in far-off Denmark they know of King Eric Glipping and his love for the marshall's wife. This scholarly monograph is a valuable contribution to the study of saga literature.

PREHISTORIC AMERICAN INDIAN DESIGN.—The figures of men and animals and geometric designs on prehistoric Indian pottery from the Mimbres Valley, New Mexico, are described by Dr. J. W. Fewkes in a monograph recently issued by the Smithsonian Institution. They are unique among the pottery from prehistoric North America, including human figures hunting, gambling, and engaged in various other occupations, animals of all kinds; and the geometric designs show many beautiful and striking combinations of carved, rectangular, and zig-zag elements, at times forming most intricate patterns. It is difficult to imagine how these ancient inhabitants of the south-west were able to achieve the accuracy and perfection of these involved designs without the aid of mechanical devices. The predominance of animal designs indicates that these largely formed the food of the ancient Mimbrenos. Most of the bowls were of the mortuary type, buried with the dead under the floors of the houses, and nearly all the bowls are "killed" or punctured, in order to serve the needs of the dead in the other world.

THE LIFE-HISTORY OF THE HORSE OXYURIS.—B. Schwartz records (*Philippine Journ. Sci.*, vol. 23, No. 1) observations on the life-history of *Oxyuris equi*, a nematode of common occurrence in the colon, cæcum, and rectum of horses. The egg develops rapidly, exposure to air being however requisite, and in four days contains a larva. When such eggs are swallowed by guinea-pigs, emergence of the larva occurs in the small intestine, the operculum present at one end of the egg being lifted or detached. No evidence of invasion by larvæ of the liver, lungs, or other organ could be found. The life-history of *O. equi* appears to be simple and direct. The author concludes that the eggs must be eliminated from the host before development can take place, and that horses become infected as the result of swallowing water or food which has become contaminated with the eggs. The larvæ hatch in the intestine, settle down in the cæcum and colon, and by successive moults attain sexual differentiation.

CRUSTACEA FROM PACIFIC ISLANDS.—The little group of atolls, of which Fanning Island is the chief, lies about a thousand miles south of the Hawaiian Islands and just north of the equator. A knowledge of its marine fauna is therefore important in attempting to delimit the Indo-Pacific region of marine zoogeography stretching east of Suez with a very uniform faunal facies which only dies out as it meets with the very different faunas of Western America, of Northern Japan, and of South Australia. As a contribution to this knowledge Mr. C. H. Edmondson offers a list of "Crustacea from Palmyra and Fanning Islands" (Bernice P. Bishop Museum, Bulletin 5, Honolulu, 1923). As the author was without access to much important literature on his subject, it is satisfactory to know that the identification of the more critical species is vouched for by Dr. Mary J. Rathbun (who describes two new species in an appendix) and Dr. Waldo L. Schmidt of Washington. One interesting species which reaches its northern limit on these islands is the tree-climbing coco-nut crab. It has been stated to occur at the Sandwich Islands, but according to the author is not found there. A sinister explanation of its absence is suggested by the remark: "On Fanning the species is becoming depleted, as it is highly prized as an article of food by the Gilbertese labourers."

CIRCULATION OF WATER IN SPONGES.—In an interesting paper on "The Relation of the Form of a Sponge to its Currents," published in the *Quarterly Journal of Microscopical Science* (vol. 67, Part II.), Dr. G. P. Bidder discusses the mechanics of the sponge-circulation. He emphasises the fact that in most sponges pressure-chambers are established whereby the velocity of the oscular flow is controlled. In dealing with the action of the flagella of the collared cells, by which the water is propelled through the canal system, he states that they appear as if labouring in thick gum, and suggests that "to understand microscopic physics it is a serviceable short-cut to think of the water as treacle." We doubt whether this idea will appeal to those who are familiar with the extraordinary rapidity of movement of cilia and flagella in general, or, to take quite a different example, the active dancing of the extremely minute particles in the vacuoles of the Desmid Closterium. A discussion of this problem by experts in physical science would be of great value to biologists.

DEVELOPMENT OF THE CORPUS LUTEUM IN COWS.—The Swiss Society of Natural Sciences has recently published as part of its fifty-sixth volume a magnificently illustrated memoir by Dr. Max Küpfer, entitled "Der normale Turnus in der Aus- und Rückbildung gelter Körper." Dr. Küpfer was formerly a pupil of Prof. E. Zschokke, who was the first to adopt the practice, now employed by the veterinarians of many different countries, of squeezing out the persistent *corpus luteum* or "yellow body" of the ovary as a means of inducing œstrus and thereby overcoming a frequent cause of sterility in cows and heifers. Dr. Küpfer's memoir deals with the gross changes in the anatomy of the ovary and more particularly the *corpus luteum* of cows at different stages, and the coloured figures, which occupy no less than twenty-eight plates, afford a very valuable guide to the variation in the appearances of the organ from the time of ovulation onwards in both pregnant and non-pregnant animals. The memoir is further illustrated by some excellent graphs, one of which represents the degrees of development and regression and the amount of overlapping of the *corpora lutea* dating from successive ovulation periods. The *corpus luteum* of pregnancy is stated to reach its maximum development at about the second month. There are also illustrations of cystic ovaries, which are another cause of sterility. We notice an error in the table on page 32, where it is incorrectly stated that according to Dr. Marshall sows do not ovulate spontaneously during œstrus. The memoir is provided with an excellent bibliography. It is issued from the scientific laboratory of the slaughter-house

at Zürich, and is one of a series on the morphology of the female reproductive organs in mammals. We understand that the histological changes in the *corpus luteum* are to be dealt with later.

ORIGIN AND EVOLUTION OF THE ELEPHANTS.—In *La Nature* for August, Depéret and Mayet give a summary of their views upon the evolution of the mammoths and elephants from the Pliocene times to the present day. The basis of this summary has already appeared this year in an important joint paper by MM. Depéret, Mayet, and Roman published in the annals of the University of Lyons. This paper, which deals with *Elephas planifrons* and the Pliocene elephants of Europe and North Africa generally, is fully illustrated in the excellent manner usual to the publications of the University. The authors make a step forward in the division of the genus Elephas, which they now separate into eight phyletic lines which themselves fall into five groups, *i.e.* those typified by *E. meridionalis, E. antiquus, and E. primigenius* (the mammoth), all of which lines became extinct by the end of the quaternary period; and by the living forms *E. indicus*, a line which is descended from *E. namadicus*, and finally, *E. africanus*, a line of unknown ancestry. The authors agree in large measure with Osborn's view that the group is polyphyletic, but, while cutting out the genus Stegodon from any close connexion with the African elephant, go further than Osborn in the subdivision of the others.

EARLY PALÆOZOIC PLANTS IN AUSTRALIA.—Recent exploration in the mountains along the Walhalla line, in Gippsland, Victoria, shows that the earliest flora of a definite structural type, largely representing the Procormophyta, is well developed in rocks that appear to range from Upper Silurian to Upper Devonian. The Silurian graptolite, Monograptus, occurs in some of these beds, while in others the association of the molluscs Panenka and Styliola with the plants seems to suggest that the bulk of the series is Devonian. Thursophyton and Haliserites (Psilophyton) are typical components of this flora. Both the flora and fauna of these interesting beds are now being worked out by a graduate of the University of Melbourne in conjunction with Mr. F. Chapman, the palæontologist of the National Museum. A detailed comparison with the Rhynie flora should throw much light on the early history of the vegetable kingdom.

DEFECTS IN COLOUR PHOTOGRAPHS.—It is well known that in the photographic reproduction of colours there are certain defects which can only be eliminated by fine etching, that is, re-etching certain *parts* of the three plates, as shown to be necessary to the skilled workman. These outstanding defects of the three-colour process have been fully investigated by Mr. A. J. Bull, and his results are described in the current number of the Journal of the Royal Photographic Society. His method was to measure the spectra of certain colours and compare their curves with those of the same colours as reproduced. The errors are due to the inks used, and are summarised as follows:—Blues and greens become darker and greyer. Blue-greens lose their greenish hue. Pinks acquire a yellow hue. Mauves become brown. Reds lose any bluish tint that they may possess. Yellows are lightened without change of hue, but oranges and browns are well reproduced. There is a tendency for the middle tones of a black to white scale to become reddish. The lightening of yellows is due to the yellow ink being very light. The inks are transparent enough to allow of the approximate calculation of the visual effect of their superposition. There seems to be little immediate hope of getting printing inks of the theoretically correct character.

POSITIVE RAYS AND THE POLAR AURORA.—In the *Physikalische Zeitschrift* of July 1, Herr H. Bongards reviews some of the available evidence as to the nature of the aurora, and is inclined to favour the view that it is caused by highly-charged, positive argon particles, sent out with very high velocity from the sun. The well-known green line, which appears to be identical with that discovered by Wiechert in the night sky of middle latitudes, has a wave length which agrees, within the limits of observational error, with a bright line in the blue spectrum of argon, and can scarcely be the same as a faint line in the multiple-lined hydrogen spectrum. There are also two bright lines in the spectrum of the red portions of the aurora, the wave lengths of which were determined with fair accuracy by Vogel in 1871; they agree with those of two lines in the red spectrum of argon; and, while further investigation is desirable, the evidence that argon is concerned in the polar aurora seems worthy of consideration. Bongards does not consider it impossible that argon exists in the air at the height of the aurora; and suggests that it may possibly be carried up by volcanic eruptions. He, however, leans strongly to the view that argon particles (possibly nuclei without external electrons) are ejected by the sun with very high velocities, which enable them to penetrate deep into the earth's atmosphere. Since they have none of the electrons concerned in radiation, they cannot emit light until, by repeated collision with air molecules, they have lost sufficient velocity to enable them to pick up the necessary electrons; this does not occur until the velocity is so low that the Doppler effect, which appears to be small in monatomic gases, cannot be noticed.

CELLULOSE ACETATE.—The *Chemical Trade Journal* for August 10 contains an article on cellulose acetate, a material which was first prepared by Schutzenberger in 1865, but remained a curiosity until Cross (1894) obtained it by the action of acetyl chloride and zinc acetate on cellulose. Cellulose acetate is the basis of aeroplane "dope" (it renders taut the fabric on the wings), lacquers, non-flaming celluloid materials, etc. These applications are described fully in the article, together with the more recent processes of manufacture and the important question of suitable solvents for the acetate.

THE PATHS OF ELECTRONS IN SOLUTION.—A paper on this subject, by L. Pisarjevski and M. Rosenberg, appears in the Jour. Russ. Phys.-Chem. Soc. (1923, 54, 533-547). When potassium iodide solutions are electrolysed, using spark electrodes, potassium hydroxide and iodine are liberated at each electrode. If starch paste be added to such solutions, a blue streak appears at the passage of each spark, which may go vertically through the solution for a distance of 9 cm., if a commutator be used, and then spreads out. The addition of phenolphthalein to the solutions produces a red streak under these conditions, which follows a more zig-zag path than the blue one, and also spreads out at its greatest depth, the coloration in both cases disappearing in about 30 seconds. These streaks may be deviated by applying a magnetic field to the solutions. The above phenomenon is explained as being due to the passage of high velocity electrons from the electrodes into the solutions; the concussion of these electrons with iodine ions liberates further electrons which again collide with ions in solution, and leave the iodine as free atoms. The free electrons also combine with potassium ions, neutralising their positive charges, and producing free potassium. It is thus possible visually to demonstrate that processes of oxidation involve the loss of electrons, and the reverse.

Brazilian Meteorological Service, 1921–23.

A SHORT report issued by Dr. Sempais Ferraz, the director of the Brazilian Meteorological Service, contains an account of the work accomplished under his auspices since its inauguration as an independent service in June 1921. Prior to this date, meteorological activities in Brazil were carried out by departments primarily constituted for some other purpose, and were confined to researches in pure climatology. What little forecasting was done was available only in the capital. No publications were issued except the Year-book for 1910 and "Instructions to Observers." With the progress of meteorology and the resulting rapid creation of new services, this dependence became impossible, and in June 1921 an independent meteorological service was established.

The numbers of second- and third-order climatological stations have been increased from 51 and 46 to 74 and 78 respectively. Rainfall stations and co-operative stations, of which there were 31 and 26 respectively in May 1921, now number 57 and 180. Inspections which were previously almost non-existent are now actively carried out all over the country. Year-books have been published for each of the years 1911–18, and those for 1919 and 1920 are in the press, while a book of Normals has also been issued. Whereas no data were published in the newspapers prior to 1921, each station is now obliged to publish fortnightly reports, and those stations that are located in capitals of States issue daily weather summaries.

Daily forecasts for the Southern States, based on synoptic data from 80 stations in Brazil, 18 in the Argentine, and 6 in Uruguay, are distributed from Rio de Janeiro and St. Paulo by telegraph or telephone. Two additional distributive centres are being established this year in St. Catherina and Parana. Forecasts are broadcasted by radio-telephone from Corcavado, while Rio's radio station sends out synoptic data and forecasts for the night and following days. A storm-signal service is in operation along the coast, and every four hours the coastal radio stations, 12 in number, broadcast the weather at the time. In the large towns flags are used to indicate the probable weather. Owing to the topographical conditions of the country, long experience is required in dealing with wind and pressure data. Empirical rules have had to be devised to meet the special circumstances. These are to be described in a forthcoming memoir entitled "Forecasting in Brazil."

Provision is being made for the study of agricultural meteorology by the establishment of stations modelled on those which formerly existed in Russia. There are at present eight of these stations in operation. A ten-days' bulletin is now published in all the leading newspapers, setting out the condition of the most important crops, pasture lands, and roads. Abridged reports are published monthly in the magazines. Phenological observations are also made.

All the rainfall data are under revision, and an atlas is to be published shortly which will include a general discussion of the different zonal dry and wet seasons. A flood service for the Parahyba river has been inaugurated, and a similar service is being arranged for the Amazon, where floods occasion considerable destruction amongst cattle.

Pilot-balloon observations are now made at seven stations. The establishment of a kite station in Alegrete (Rio Grande do Sul) is expected to reveal interesting data of the secondary circulation in a region which Brazilian meteorologists have described as the "turn-table" of moving highs and a frequent path of outgoing depressions. A second kite station to be established at Ceara is expected to furnish an explanation of the curious irregular droughts of north-eastern Brazil and a possible method of forecasting them. It is hoped that the pursuit of aerological research in Brazil, besides its practical assistance to aviation, "will help the eminent meteorologists of the world in their search for the missing links of general dynamic theories of the atmosphere."

This record of twenty months' work is all the more gratifying when account is taken of the difficulties which, as the author points out, beset meteorological activity in Brazil. Brazil has a highly intellectual *élite*, but the mass of the people have scarcely any education. Observers have to be paid, as voluntary co-operation at present is unavailable. P. I. M.

Sir Isaac Newton and the S.P.C.K.

SOME recent references which a correspondent has recently had occasion to make to Thomas Hollis's "Memoirs," published in 1780 (4to, 2 vols.), have led to the unearthing by him of an interesting draft letter attributed to Sir Isaac Newton, of which no mention is made in Brewster's "Life." The chronicler relates that, in September 1764, Mr. Hawksbee, son of Mr. Hawksbee, sometime clerk to the Royal Society, waited upon Mr. Hollis with the copy of a paper written by Sir Isaac Newton, containing minutes of his opinion against a proposal which had been made to the Royal Society to accommodate the members of the Society for Promoting Christian Knowledge, then newly instituted, with the use of the Society's house for its meetings. Mr. Hawksbee, the father, had shown Hollis the original in Sir Isaac's own handwriting, but could not be prevailed on to part with it. He goes on to say that Hollis was glad, however, to obtain a copy in Hawksbee's handwriting, from his son, a soldier in the artillery.

In 1698–9 the S.P.C.K. was beginning to take definite shape as a result of the efforts of a small band of enthusiasts. Indeed, a tentative plan of constitution was put forward about then by Dr. Bray, who suggested that "these persons" be incorporated by charter as [like] the Royal Society, and Sons of the Clergy; and be thereby empowered to "meet and consult as often as there shall be occasion." Sir Isaac's letter was drawn up apparently while the Royal Society was in occupation at Gresham College, and in the early days of the S.P.C.K. Sir Isaac says, "I never heard of them before."

Subjoined is the letter referred to above. Its terms are of singular interest as a defence against encroachment:

"We have a reputation abroad, and the Society for Promoting Christian Knowledge, are scarce known at home; I never heard of them before. And to admit them into our bosom would be, in a little time, to share our reputation with them.

"We are incorporated by the crown; and to herd ourselves with a club not yet incorporated, would be ingratitude to our Founder.

"Our house was built by benefactions; and to divert it to other uses than our benefactors intended would be ingratitude to their memory; and a discouragement to future benefactions.

"If we once lend our house, time will make custom,

and custom will give right: It is easier to deny in the beginning than afterward.

"It is a fundamental rule of the Society not to meddle with religion; and the reason is, that we may give no occasion to religious bodies to meddle with us.

"The Society for Promoting Christian Knowledge, have a splendid title, but we are to regard not names, but things. If all their members are not men of exemplary lives and conversation, some of them, by misdemeanors, may bring reflections upon us; and why should we run the hazard?

"If we comply, we may dissatisfy some of those that are against it; especially those that are of other religions, and make them leave our meetings, which are already too thin.

"There are many vestries in London; and it is more proper for a religious society to meet in a vestry or —— than in the house of a society which is mixed of men of all religions, and meddles with none.

"Those of the Christian Society have dining rooms of their own, and may lend them by turns to their meetings. And the tenth commandment is, 'Thou shalt not covet thy neighbour's house.'

"This proposal can be of no advantage to us; but may prove disadvantageous; and we have, all of us, at our admission, promised, under our hands, to consult the good of the society; and ought not to break the fundamental covenant upon which we were admitted."

Mechanism of Stomatal Movement in Plants.

IT has been generally recognised for a long time past that the stomata of the leaf opened when more water was absorbed by the guard cells and closed when water passed from the guard cells into the surrounding tissues. It is also frequently assumed that the mechanism by which this water exchange takes place must be associated with the presence of green chloroplasts in the guard cells, the other epidermal cells being usually free from chlorophyll.

The mechanism by which the osmotic concentration of the cell sap of the guard cell is controlled has, however, remained obscure; of late years experimental work has thrown light upon this problem, and a valuable summary of this work is given by Friedl Weber in *Die Naturwissenschaften*, Vol. 11, Heft 17, April 27. Lloyd's work had shown that the movement of the guard cells is not connected with the direct photosynthesis of carbon dioxide by the guard cells, the cells around the closed stoma at night being packed with starch, while in the early morning, in daylight, the starch rapidly hydrolyses and the stoma opens.

Iljin's series of papers now suggest that the varying activity of diastatic enzymes under different conditions are intimately associated with the stomatal mechanism. Iljin showed that with stomata closed the guard cells were usually full of starch, the starch disappearing as the stomata open. Further experiments showed that sodium and potassium salts accelerated starch hydrolysis, while calcium salts prevented it; inorganic anions produced less effect, but citrates and acetates exerted considerable effect.

The effect of the various salts upon the reaction of the cell has to be carefully considered, the slightest increase in hydrion concentration favouring starch hydrolysis and stomatal opening; the slightest decrease, starch accumulation and stomatal closure. The reaction of a stoma to these various factors differs with the plant, halophytes, for example, showing themselves very insensitive to changes in salt concentration, while a plant like *Rumex acetosa*, with very acid sap, is especially sensitive. It is clear that our conception of the mechanism of control of stomatal aperture will require re-examination in the light of this interesting work. Thus Linsbauer's observations on the movement of the guard cells with change of light intensity, or with alterations in the carbon dioxide content of the air, may find their explanation in the consequent alteration of reaction in the cell sap of the guard cell.

University and Educational Intelligence.

DURHAM.—As a result of the recent decision of the council of Armstrong College to build a College Library, all practising members of the Northern Architectural Association, and a few architects in other parts of Great Britain, were invited to submit competitive designs for the building. The first premium has been awarded to Mr. A. Dunbar Smith, who has been appointed architect of the library, and work will proceed forthwith. The building will consist of a reading-room seating 122 readers, storage space for 175,000 volumes, with accommodation for 55 research students, administrative rooms, and photographic laboratory, and is so designed that additional storage space for 60,000 volumes may be added when required.

MANCHESTER.—On Tuesday, September 11, Sir George Beilby opened the new buildings to be occupied by the Department of Metallurgy in the University. Although founded in 1906, the home of the Department has so far been merely a few laboratories loaned by the Chemistry Department. Especially from the point of view of the research workers this arrangement was far from satisfactory. In the new buildings four research laboratories will be available, in addition to general laboratories for pyrometry, mechanical testing, and metallography. A small foundry and machinery room together with the heat-treatment laboratory will further offer facilities both for teaching and research which have hitherto been incompletely available. The main general laboratory, named after Henry Cort, the eighteenth-century metallurgist, the inventor of rolling metals in grooved rolls and a pioneer in connexion with the puddling process, is well equipped for the determination of the physical properties of metals at temperatures above the normal. A small laboratory is devoted to fuel examinations, so that it may be claimed that the new buildings afford excellent facilities for both teaching and research in metallurgy, metallography, and fuel. Since 1910 sixty papers have been published in recognised journals dealing with the research work done in the Department. Among the more important of the subjects investigated may be cited work on high-speed steel, the growth of cast iron on repeated heatings, chromium steels, including stainless steel, the influence of gases on iron and steel, the production of high-pressure castings, and the hardness and elastic limits of metals both at and above room temperatures. On the foundation laid by Prof. H. B. Dixon and continued by his successors in the chair of metallurgy, Profs. H. C. H. Carpenter and C. A. Edwards, an edifice worthy of their labours has at length been erected.

THE following free public Gresham lectures will be delivered at Gresham College, Basinghall Street, E.C., at 6 o'clock on the dates given: Astronomy, by A. R. Hinks, on October 9, 10, 11, and 12; Physic, by Sir Robert Armstrong-Jones, on October 16, 17, 18, and 19; and Geometry, by W. H. Wagstaff, on October 23, 24, 25, and 26.

Societies and Academies.

PARIS.

Academy of Sciences, August 20.—M. Guillaume Bigourdan in the chair.—A. **Lacroix**: The constitution of the Rockall bank. The island of Rockall emerges from a submarine bank defined by depths of 183 metres, and measures about 70 miles. Blocks of basalt have been frequently found on this bank by fishermen and by systematic dredging. Two views have been put forward as to the origin of these blocks. Forbes suggested transportation by glaciers from Iceland or Jan Mayen island, but G. A. J. Cole considers them as constituting the debris of a submerged basaltic plateau, and this view was accepted by Judd. Detailed examination and chemical analysis of the rocks collected by Charcot in 1921 on the Rockall bank confirms Cole's hypothesis.—Charles **Richet**: The influence of removal of the spleen in cases of insufficient feeding. Details of experiments lasting 126 days on five dogs without spleens and four normal dogs, as controls.—Paul **Vuillemin**: Variation and fluctuation in the number of stigmata of Papaver.—Charles **Nordmann**: The mechanism of hovering flight and the morphology of hovering birds.—N. Vasilesco **Karpen**: The electromotive force of batteries, chemical affinity, and molecular attraction. The formulæ for the E.M.F. of a Daniell cell given by Nernst and by Helmholtz are regarded by the author as inconsistent, and other objections are raised against the Nernst expression. A modified Nernst theory is proposed based on the Laplacian attraction exerted on the molecules and ions situated at the level of the surface of separation between two different media.—L. **Bert**: The preparation and application to organic syntheses of the magnesium derivative of *p*-bromcumene. *p*-Bromcumene has not hitherto been utilised in syntheses by the Grignard reaction, on account of its high price. Recently, isopropyl alcohol has been obtainable commercially at a low price, and this can readily be converted into isopropyl bromide, cumene, and *p*-bromcumene, with good yields. Details are given of the best method of preparing the magnesium compound of *p*-bromcumene and of some compounds prepared by means of it.—G. **Vavon** and D. **Ivanoff**: Catalytic hydrogenation and steric hindrance. The study of some nonanones. Four saturated C_9 ketones were studied, dipropylacetone, methylethylpropylacetone, dimethyldiethylacetone, and hexamethylacetone. Both the formation of oxims, and of phenylhydrazones, as well as the catalytic hydrogenation of the ketones in the presence of platinum, follow the law of steric hindrance.—P. **Lebeau**: The quantity and the nature of the gases evolved by solid combustibles under the action of heat in a vacuum: anthracites. The volume of gas given by various combustibles is not a function of the percentage of volatile matter. Anthracites, poor in volatile matter, give volumes of gas of the same order as bituminous coals. The gas from anthracite contains high proportions of hydrogen.—M. de **Rohan-Chabot**: Magnetic measurements in Angola and in Rhodesia by the Rohan-Chabot expedition. Observations taken in 1912 and 1913 at 44 stations in Angola and 3 in Rhodesia are given in tabular form.—Fernand **Chodat** and A. **Kotzareff**: The difference between pathological and normal sera and the autophylactic property of the latter.—A. **Paillot**: A new flagellosis of an insect and a process of natural infection not hitherto described.—C. **Levaditi** and S. **Nicolau**: The persistence of the neurovaccine in the testicle, the ovary, and the lung of animals having acquired anti-vaccinal immunity.

SYDNEY

Royal Society of New South Wales, July 4.—Mr. R. H. Cambage, president, in the chair.—G. J. **Burrows** and F. **Eastwood**: Molecular solution volumes in ethyl alcohol. The authors have measured the densities of alcoholic solutions of various organic compounds, and calculated their molecular solution volumes. It has been found that the solution of a non-associated solute in alcohol causes a contraction in volume of 20 c.c. per gram molecule of solute, and that a smaller contraction indicates that the solute is associated in the liquid state.—E. **Cheel**: Two additional species of Leptospermum. Two additional species of plants belonging to the tea-tree group were described. One species, namely, *Leptospermum coriaceum*, was originally described by Baron von Mueller as a distinct species, but was afterwards merged as a synonym with the common "sand stay" or coastal tea-tree of N. S. Wales (*L. lævigatum*). Certain structural characters, however, as well as geographical range from Sandringham in Victoria through Murray Bridge in S. Australia to Ooldea on the Transcontinental Line, serve to distinguish this species. The second species, which may be called the "small-fruited tea-tree" (*L. microcarpum*) is confined chiefly to the northern parts of N. S. Wales and Queensland. It has smooth whip-stick-like branches, and sheds its bark like some of the gum-trees.—A. R. **Penfold**: The essential oils of *Callistemon lanceolatus* and *C. viminalis*. The essential oils from two well-known "bottle brushes," *Callistemon lanceolatus* and *C. viminalis*, were described. The former inhabits the swampy situations of the coast extending to about Gloucester, while the latter is a denizen of the banks of the rivers of the far north coast and extends into Queensland. The essential oils were of a pale yellow colour, and were practically identical with a medicinal eucalyptus oil. Unfortunately, the low percentage yield of oil, 0·2 per cent., precludes their successful exploitation, despite their abundance, on account of the higher yield of 2 to 3 per cent. obtainable from the eucalypts.

Official Publications Received.

Universidad Nacional de La Plata Museo. Habitantes Neolíticos del lago Buenos Aires: Documentos para la Antropología física de la Patagonia Austral. Por Dr. José Imbelloni. Pp. 85-160. (Buenos Aires.)

Bernice P. Bishop Museum. Bulletin 4: Report of the Director for 1922. By Herbert E. Gregory. Pp. 38. (Honolulu, Hawaii.)

Loughborough College, Leicestershire. Calendar, Session 1923–24. Pp. xiv+213+5 plates. (Loughborough.)

Prospectus of University Courses in the Municipal College of Technology, Manchester. Session 1923–24. Pp. 225. (Manchester.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 8: Significant Movements in City School Systems. By W. S. Deffenbaugh. Pp. 28. (Washington: Government Printing Office.)

State of Illinois. Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 14, Art. 8: First Report on a Forestry Survey of Illinois. By Robert B. Miller. Pp. vi+291-377+27 plates. Bulletin, Vol. 14, Art. 9: The Determination of Hydrogen Ion Concentration in connection with Freshwater Biological Studies. By Victor E. Shelford. Pp. iv+379-395. (Urbana, Ill.)

Field Museum of Natural History. Report Series, Vol. 6, No. 2: Annual Report of the Director to the Board of Trustees for the Year 1922. (Publication 213.) Pp. v+82-163. (Chicago.)

Field Museum of Natural History. Anthropological Series, Vol. 6, No. 5: The Hopewell Mound Group of Ohio. By Warren K. Moorehead. (Publication 211.) Pp. 75-185+48 plates. Anthropological Series, Vol. 14, No. 2: The Tinguian; Social, Religious, and Economic Life of a Philippine Tribe. By Fay-Cooper Cole; with a Chapter on Music by Albert Gale. (Publication 209.) Pp. vi+231-493+83 plates. (Chicago.)

Merchant Venturers' Technical College. Calendar for the Sixty-eighth Session, 1923–24. Pp. 53. (Bristol.) 6d.

Università Commerciale Luigi Bocconi. Annuario 1922–1923. Pp. 204. (Milano.)

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December 1922. Pp. 35. (Kingston, Jamaica.)

British Legion: Officers' Benevolent Department. Third Annual Report and Accounts, for the Year ending 31st December 1922. Pp. 29. (London: 48 Grosvenor Square.)

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The Electrical Structure of Matter.[1]

By Prof. Sir ERNEST RUTHERFORD, D.Sc., LL.D., Ph.D., F.R.S., President of the British Association.

IT was in 1896 that this Association last met in Liverpool, under the presidency of the late Lord Lister, that great pioneer in antiseptic surgery, whose memory is held in affectionate remembrance by all nations. His address, which dealt mainly with the history of the application of antiseptic methods to surgery and its connexion with the work of Pasteur, that prince of experimenters, whose birth has been so fittingly celebrated this year, gave us in a sense a completed page of brilliant scientific history. At the same time, in his opening remarks, Lister emphasised the importance of the discovery by Röntgen of a new type of radiation, the X-rays, which we now see marked the beginning of a new and fruitful era in another branch of science.

The visit to Liverpool in 1896 was for me a memorable occasion, for it was here that I first attended a meeting of this Association, and here that I read my first scientific paper. But of much more importance, it was here that I benefited by the opportunity, which these gatherings so amply afford, of meeting for the first time many of the distinguished scientific men of Great Britain and the foreign representatives of science who were the guests of this city on that occasion. The year 1896 has always seemed to me a memorable one for other reasons, for on looking back with some sense of perspective we cannot fail to recognise that the last Liverpool meeting marked the beginning of what has been aptly termed the heroic age of physical science. Never before in the history of physics has there been witnessed such a period of intense activity when discoveries of fundamental importance have followed one another with such bewildering rapidity.

The discovery of X-rays by Röntgen had been published to the world in 1895, while the discovery of the radioactivity of uranium by Becquerel was announced early in 1896. Even the most imaginative of our scientific men could never have dreamed at that time of the extension of our knowledge of the structure of matter that was to develop from these two fundamental discoveries, but in the records of the Liverpool meeting we see the dawning recognition of the possible consequences of the discovery of X-rays, not only in their application to medicine and surgery, but also as a new and powerful agent for attacking some of the fundamental problems of physics. The address of Sir J. J. Thomson, president of Section A, was devoted mainly to a discussion of the nature of the X-rays, and the remarkable properties induced in gases by the passage of X-rays through them—the beginning of a new and fruitful branch of study.

In applied physics, too, this year marked the beginning of another advance. In the discussion of a paper which I had the honour to read, on a new magnetic detector of electrical waves, the late Sir William Preece told the meeting of the successful transmission of signals for a few hundred yards by electric waves which had been made in England by a young Italian, G. Marconi. The first public demonstration of signalling for short distances by electric waves had been given by Sir Oliver Lodge at the Oxford Meeting of this Association in 1894. It is startling to recall the rapidity of the development from such small beginnings of the new method of wireless intercommunication over the greatest terrestrial distances. In the last few years this has been followed by the even more rapid growth of the allied subject of radiotelephony as a practical means of broadcasting speech and music to distances only limited by the power of the transmitting station. The rapidity of these technical advances is an illustration of the close interconnexion that must exist between pure and applied science if rapid and sure progress is to be made. The electrical engineer has been able to base his technical developments on the solid foundation of Maxwell's electromagnetic theory and its complete verification by the researches of Hertz, and also by the experiments of Sir Oliver Lodge in the University of Liverpool—a verification completed long before the practical possibilities of this new method of signalling had been generally recognised. The later advances in radiotelegraphy and radiotelephony have largely depended on the application of the results of fundamental researches on the properties of electrons, as illustrated in the use of the thermionic valve or electron tube which has proved such an invaluable agent for both the transmission and reception of electric waves.

It is of great interest to note that the benefits of this union of pure and applied research have not been one-sided. If the fundamental researches of the workers in pure science supply the foundations on which the applications are surely built, the successful practical application in turn quickens and extends the interest of the investigator in the fundamental problem, while the development of new methods and appliances required for technical purposes often provides the investigator with means of attacking still more difficult questions. This important reaction between pure and applied science can be illustrated in many branches of knowledge. It is particularly manifest in the industrial development of X-ray radiography for therapeutic and industrial purposes, where the development on a large scale of special X-ray tubes and improved methods of excitation has given the physicist much more efficient tools to carry out his researches on the nature of the rays themselves and on the structure of the atom. In this age no one can draw any sharp line of distinction

[1] Inaugural address delivered to the British Association at Liverpool on September 12.

between the importance of so-called pure and applied research. Both are equally essential to progress, and we cannot but recognise that without flourishing schools of research on fundamental matters in our universities and scientific institutions technical research must tend to wither. Fortunately there is little need to labour this point at the moment, for the importance of a training in pure research has been generally recognised. The Department of Scientific and Industrial Research has made a generous provision of grants to train qualified young men of promise in research methods in our scientific institutions, and has aided special fundamental researches which are clearly beyond the capacity of a laboratory to finance from its own funds. Those who have the responsibility of administering the grants in aid of research for both pure and applied science will need all their wisdom and experience to make a wise allocation of funds to secure the maximum of results for the minimum of expenditure. It is fatally easy to spend much money in a direct frontal attack on some technical problem of importance when the solution may depend on some addition to knowledge which can be gained in some other field of scientific inquiry possibly at a trifling cost. It is not in any sense my purpose to criticise those bodies which administer funds for fostering pure and applied research, but to emphasise how difficult it is to strike the correct balance between the expenditure on pure and applied science in order to achieve the best results in the long run.

It is my intention here to refer very briefly to some of the main features of that great advance in knowledge of the nature of electricity and matter which is one of the salient features of the interval since the last meeting of this Association in Liverpool.

In order to view the extensive territory which has been conquered by science in this interval, it is desirable to give a brief summary of the state of knowledge of the constitution of matter at the beginning of this epoch. Ever since its announcement by Dalton the atomic theory has steadily gained ground, and formed the philosophic basis for the explanation of the facts of chemical combination. In the early stages of its application to physics and chemistry it was unnecessary to have any detailed knowledge of the dimensions or structure of the atom. It was only necessary to assume that the atoms acted as individual units, and to know the relative masses of the atoms of the different elements. In the next stage, for example, in the kinetic theory of gases, it was possible to explain the main properties of gases by supposing that the atoms of the gas acted as minute perfectly elastic spheres. During this period, by the application of a variety of methods, many of which were due to Lord Kelvin, rough estimates had been obtained of the absolute dimensions and mass of the atoms. These brought out the minute size and mass of the atom and the enormous number of atoms necessary to produce a detectable effect in any kind of measurement. From this arose the general idea that the atomic theory must of necessity for ever remain unverifiable by direct experiment, and for this reason it was suggested by one school of thought that the atomic theory should be banished from the teaching of chemistry, and that the law of multiple proportions should be accepted as the ultimate fact of chemistry.

While the vaguest ideas were held as to the possible structure of atoms, there was a general belief among the more philosophically minded that the atoms of the elements could not be regarded as simple unconnected units. The periodic variations of the properties of the elements brought out by Mendeléeff were only explicable if atoms were similar structures in some way constructed of similar material. We shall see that the problem of the constitution of atoms is intimately connected with our conception of the nature of electricity. The wonderful success of the electromagnetic theory had concentrated attention on the medium or ether surrounding the conductor of electricity, and little attention had been paid to the actual carriers of the electric current itself. At the same time the idea was generally gaining ground that an explanation of the results of Faraday's experiments on electrolysis was only possible on the assumption that electricity, like matter, was atomic in nature. The name "electron" had even been given to this fundamental unit by Johnstone Stoney, and its magnitude roughly estimated, but the full recognition of the significance and importance of this conception belongs to the new epoch.

For the clarifying of these somewhat vague ideas, the proof in 1897 of the independent existence of the electron as a mobile electrified unit, of mass minute compared with that of the lightest atom, was of extraordinary importance. It was soon seen that the electron must be of a constituent of all the atoms of matter, and that optical spectra had their origin in their vibrations. The discovery of the electron and the proof of its liberation by a variety of methods from all the atoms of matter was of the utmost significance, for it strengthened the view that the electron was probably the common unit in the structure of atoms which the periodic variation of the chemical properties had indicated. It gave for the first time some hope of the success of an attack on that most fundamental of all problems—the detailed structure of the atom. In the early development of this subject science owes much to the work of Sir J. J. Thomson, both for the boldness of his ideas and for his ingenuity in developing methods for estimating the number of electrons in the atom, and in probing its structure. He early took the view that the atom must be an electrical structure, held together by electrical forces, and showed in a general way lines of possible explanation of the variation of physical and chemical properties of the elements, exemplified in the periodic law.

In the meantime our whole conception of the atom and of the magnitude of the forces which held it together were revolutionised by the study of radioactivity. The discovery of radium was a great step in advance, for it provided the experimenter with powerful sources of radiation specially suitable for examining the nature of the characteristic radiations which are emitted by the radioactive bodies in general. It was soon shown that the atoms of radioactive matter were undergoing spontaneous transformation, and that the characteristic radiations emitted, namely, the α-, β-, and γ-rays, were an accompaniment and consequence of these atomic explosions. The wonderful succession of changes that occur in uranium and thorium, more

than thirty in number, was soon disclosed and simply interpreted on the transformation theory. The radioactive elements provide us for the first time with a glimpse into Nature's laboratory, and allow us to watch and study, but not to control, the changes that have their origin in the heart of the radioactive atoms. These atomic explosions involve energies which are gigantic compared with those involved in any ordinary physical or chemical process. In the majority of cases an α-particle is expelled at high speed, but in others a swift electron is ejected often accompanied by a γ-ray, which is a very penetrating X-ray of high frequency. The proof that the α-particle is a charged helium atom for the first time disclosed the importance of helium as one of the units in the structure of the radioactive atoms, and probably also in that of the atoms of most of the ordinary elements. Not only then have the radioactive elements had the greatest direct influence on natural philosophy, but in subsidiary ways they have provided us with experimental methods of almost equal importance. The use of α-particles as projectiles with which to explore the interior of the atom has definitely exhibited its nuclear structure, has led to artificial disintegration of certain light atoms, and promises to yield more information yet as to the actual structure of the nucleus itself.

The influence of radioactivity has also extended to yet another field of study of fascinating interest. We have seen that the first rough estimates of the size and mass of the atom gave little hope that we could detect the effect of a single atom. The discovery that the radioactive bodies expel actual charged atoms of helium with enormous energy altered this aspect of the problem. The energy associated with a single α-particle is so great that it can readily be detected by a variety of methods. Each α-particle, as Sir William Crookes first showed, produces a flash of light easily visible in a dark room when it falls on a screen coated with crystals of zinc sulphide. This scintillation method of counting individual particles has proved invaluable in many researches, for it gives us a method of unequalled delicacy for studying the effects of single atoms. The α-particle can also be detected electrically or photographically, but the most powerful and beautiful of all methods is that perfected by Mr. C. T. R. Wilson for observing the track through a gas, not of an α-particle alone, but of any type of penetrating radiation which produces ions or of electrified particles along its path. The method is comparatively simple, depending on the fact, first discovered by him, that if a gas saturated with moisture is suddenly cooled each of the ions produced by the radiation becomes the nucleus of a visible drop of water. The water-drops along the track of the α-particle are clearly visible to the eye, and can be recorded photographically. These beautiful photographs of the effect produced by single atoms or single electrons appeal, I think, greatly to all scientific men. They not only afford convincing evidence of the discrete nature of these particles, but also give us new courage and confidence that the scientific methods of experiment and deduction are to be relied upon in this field of inquiry; for many of the essential points brought out so clearly and concretely in these photographs were correctly deduced long before such confirmatory photographs were available. At the same time, a minute study of the detail disclosed in these photographs gives us most valuable information and new clues on many recondite effects produced by the passage through matter of these flying projectiles and penetrating radiations.

In the meantime a number of new methods had been devised to fix with some accuracy the mass of the individual atom and the number in any given quantity of matter. The concordant results obtained by widely different physical principles gave great confidence in the correctness of the atomic idea of matter. The method found capable of most accuracy depends on the definite proof of the atomic nature of electricity and the exact valuation of this fundamental unit of charge. We have seen that it was early surmised that electricity was atomic in nature. This view was confirmed and extended by a study of the charges carried by electrons, α-particles, and the ions produced in gases by X-rays and the rays from radioactive matter. It was first shown by Townsend that the positive or negative charge carried by an ion in gases was invariably equal to the charge carried by the hydrogen ion in the electrolysis of water, which we have seen was assumed, and assumed correctly, by Johnstone Stoney to be the fundamental unit of charge. Various methods were devised to measure the magnitude of this fundamental unit; the best known and most accurate is Millikan's, which depends on comparing the pull of an electric field on a charged droplet of oil or mercury with the weight of the drop. His experiments gave a most convincing proof of the correctness of the electronic theory, and gave a measure of this unit, the most fundamental of all physical units, with an accuracy of about one in a thousand. Knowing this value, we can by the aid of electrochemical data easily deduce the mass of the individual atoms and the number of molecules in a cubic centimetre of any gas with an accuracy of possibly one in a thousand, but certainly better than one in a hundred. When we consider the minuteness of the unit of electricity and of the mass of the atom, this experimental achievement is one of the most notable even in an era of great advances.

The idea of the atomic nature of electricity is very closely connected with the attack on the problem of the structure of the atom. If the atom is an electrical structure it can only contain an integral number of charged units, and, since it is ordinarily neutral, the number of units of positive charge must equal the number of negative. One of the main difficulties in this problem has been the uncertainty as to the relative part played by positive and negative electricity in the structure of the atom. We know that the electron has a negative charge of one fundamental unit, while the charged hydrogen atom, whether in electrolysis or in the electric discharge, has a charge of one positive unit. But the mass of the electron is only 1/1840 of the mass of the hydrogen atom, and though an extensive search has been made, not the slightest evidence has been found of the existence of a positive electron of small mass like the negative. In no case has a positive charge been found associated with a mass less than that of the charged atom of hydrogen. This difference between positive and negative electricity is at first sight very surprising, but the deeper we pursue our inquiries the more this fundamental difference

between the units of positive and negative electricity is emphasised. In fact, as we shall see later, the atoms are quite unsymmetrical structures with regard to the positive and negative units contained in them, and indeed it seems certain that if there were not this difference in mass between the two units, matter, as we know it, could not exist.

It is natural to inquire what explanation can be given of this striking difference in mass of the two units. I think all scientific men are convinced that the small mass of the negative electron is to be associated entirely with the energy of its electrical structure, so that the electron may be regarded as a disembodied atom of negative electricity. We know that an electron in motion, in addition to possessing an electric field, also generates a magnetic field around it, and energy in the electromagnetic form is stored in the medium and moves with it. This gives the electron an apparent or electrical mass, which, while nearly constant for slow speeds, increases rapidly as its velocity approaches that of light. This increase of mass is in good accord with calculation, whether based on the ordinary electrical theory or on the theory of relativity. Now we know that the hydrogen atom is the lightest of all atoms, and is presumably the simplest in structure, and that the charged hydrogen atom, which we shall see is to be regarded as the hydrogen nucleus, carries a unit positive charge. It is thus natural to suppose that the hydrogen nucleus is the atom of positive electricity, or positive electron, analogous to the negative electron, but differing from it in mass. Electrical theory shows that the mass of a given charge of electricity increases with the concentration, and the greater mass of the hydrogen nucleus would be accounted for if its size were much smaller than that of the electron. Such a conclusion is supported by evidence obtained from the study of the close collisions of α-particles with hydrogen nuclei. It is found that the hydrogen nucleus must be of minute size, of radius less than the electron, which is usually supposed to be about 10^{-13} cm.; also the experimental evidence is not inconsistent with the view that the hydrogen nucleus may actually be much smaller than the electron. While the greater mass of the positive atom of electricity may be explained in this way, we are still left with the enigma why the two units of electricity should differ so markedly in this respect. In the present state of our knowledge it does not seem possible to push this inquiry further, or to discuss the problem of the relation of these two units.

We shall see that there is the strongest evidence that the atoms of matter are built up of these two electrical units, namely the electron and the hydrogen nucleus or proton, as it is usually called when it forms part of the structure of any atom. It is probable that these two are the fundamental and indivisible units which build up our universe, but we may reserve in our mind the possibility that further inquiry may some day show that these units are complex, and divisible into even more fundamental entities. On the views we have outlined, the mass of the atom is the sum of the electrical masses of the individual charged units composing its structure, and there is no need to assume that any other kind of mass exists. At the same time, it is to be borne in mind that the actual mass of an atom may be somewhat less than the sum of the masses of component positive and negative electrons when in the free state. On account of the very close proximity of the charged units in the nucleus of an atom, and the consequent disturbance of the electric and magnetic fields surrounding them, such a decrease of mass is to be anticipated on general theoretical grounds.

We must now look back again to the earlier stages of the present epoch in order to trace the development of our ideas on the detailed structure of the atom. That electrons as such were important constituents was clear by 1900, but little real progress followed until the part played by the positive charges was made clear. New light was thrown on this subject by examining the deviation of α-particles when they passed through the atoms of matter. It was found that occasionally a swift α-particle was deflected from its rectilinear path through more than a right angle by an encounter with a single atom. In such a collision the laws of dynamics ordinarily apply, and the relation between the velocities of the colliding atoms before and after collision are exactly the same as if the two colliding particles are regarded as perfectly elastic spheres of minute dimensions. It must, however, be borne in mind that in these atomic collisions there is no question of mechanical impacts such as we observe with ordinary matter. The reaction between the two particles occurs through the intermediary of the powerful electric fields that surround them. Beautiful photographs illustrating the accuracy of these laws of collision between an α-particle and an atom have been obtained by Messrs. Wilson, Blackett, and others, while Mr. Wilson has recently obtained many striking illustrations of collisions between two electrons. Remembering the great kinetic energy of the α-particle, its deflexion through a large angle in a single atomic encounter shows clearly that very intense deflecting forces exist inside the atom. It seemed clear that electric fields of the required magnitude could be obtained only if the main charge of the atom were concentrated in a minute nucleus. From this arose the conception of the nuclear atom, now so well known, in which the heart of the atom is supposed to consist of a minute but massive nucleus, carrying a positive charge of electricity, and surrounded at a distance by the requisite number of electrons to form a neutral atom.

A detailed study of the scattering of α-particles at different angles, by Geiger and Marsden, showed that the results were in close accord with this theory, and that the intense electric forces near the nucleus varied according to the ordinary inverse square law. In addition, the experiments allowed us to fix an upper limit for the dimensions of the nucleus. For a heavy atom like that of gold the radius of the nucleus, if supposed to be spherical, was less than one-thousandth of the radius of the complete atom surrounded by its electrons, and certainly less than 4×10^{-12} cm. All the atoms were found to show this nuclear structure, and an approximate estimate was made of the nuclear charge of different atoms. This type of nuclear atom, based on direct experimental evidence, possesses some very simple properties. It is obvious that the number of units of resultant positive charge in the nucleus

fixes the number of the outer planetary electrons in the neutral atom. In addition, since these outer electrons are in some way held in equilibrium by the attractive forces from the nucleus, and, since we are confident from general physical and chemical evidence that all atoms of any one element are identical in their external structure, it is clear that their arrangement and motion must be governed entirely by the magnitude of the nuclear charge. Since the ordinary chemical and physical properties are to be ascribed mainly to the configuration and motion of the outer electrons, it follows that the properties of an atom are defined by a whole number representing its nuclear charge. It thus becomes of great importance to determine the value of this nuclear charge for the atoms of all the elements.

Data obtained from the scattering of α-particles, and also from the scattering of X-rays by light elements, indicated that the nuclear charge of an element was numerically equal to about half the atomic weight in terms of hydrogen. It was fairly clear from general evidence that the hydrogen nucleus had a charge one, and the helium nucleus (the α-particle) a charge two. At this stage another discovery of great importance provided a powerful method of attack on this problem. The investigation by Laue on the diffraction of X-rays by crystals had shown definitely that X-rays were electromagnetic waves of much shorter wavelength than light, and the experiments of Sir William Bragg and W. L. Bragg had provided simple methods for studying the spectra of a beam of X-rays. It was found that the spectrum in general shows a continuous background on which is superimposed a spectrum of bright lines. At this stage H. G. J. Moseley began a research with the intention of deciding whether the properties of an element depended on its nuclear charge rather than on its atomic weight as ordinarily supposed. For this purpose the X-ray spectra emitted by a number of elements were examined and found to be all similar in type. The frequency of a given line was found to vary very nearly as the square of a whole number which varied by unity in passing from one element to the next. Moseley identified this whole number with the atomic or ordinal number of the elements when arranged in increasing order of atomic weight, allowance being made for the known anomalies in the periodic table and for certain gaps corresponding to possible but missing elements. He concluded that the atomic number of an element was a measure of its nuclear charge, and the correctness of this deduction has been recently verified by Chadwick by direct experiments on the scattering of α-particles. Moseley's discovery is of fundamental importance, for it not only fixes the number of electrons in all the atoms, but also shows conclusively that the properties of an atom, as had been surmised, are determined not by its atomic weight but by its nuclear charge. A relation of unexpected simplicity is thus found to hold between the elements. No one could have anticipated that with few exceptions all atomic numbers between hydrogen 1, and uranium 92, would correspond to known elements. The great power of Moseley's law in fixing the atomic number of an element is well illustrated by the recent discovery by Coster and Hevesy in Copenhagen of the missing element of atomic number 72, which they have named "hafnium."

Once the salient features of the structure of atoms have been fixed and the number of electrons known, the further study of the structure of the atom falls naturally into two great divisions: one, the arrangement of the outer electrons which controls the main physical and chemical properties of an element, and the other, the structure of the nucleus on which the mass and radioactivity of the atom depend. On the nuclear theory the hydrogen atom is of extreme simplicity, consisting of a singly-charged positive nucleus with only one attendant electron. The position and motions of the single electron must account for the complicated optical spectrum, and whatever physical and chemical properties are to be attributed to the hydrogen atom. The first definite attack on the problem of the electronic structure of the atom was made by Niels Bohr. He saw clearly that, if this simple constitution was assumed, it is impossible to account for the spectrum of hydrogen on the classical electrical theories, but that a radical departure from existing views was necessary. For this purpose he applied to the atom the essential ideas of the quantum theory which had been developed by Planck for other purposes, and had been found of great service in explaining many fundamental difficulties in other branches of science. On Planck's theory, radiation is emitted in definite units or quanta, in which the energy E of a radiation is equal to $h\nu$ where ν is the frequency of the radiation measured by the ordinary methods and h a universal constant. This quantum of radiation is not a definite fixed unit like the atom of electricity, for its magnitude depends on the frequency of the radiation. For example, the energy of a quantum is small for visible light, but becomes large for radiation of high frequency corresponding to the X-rays or the γ-rays from radium.

Time does not allow me to discuss the underlying meaning of the quantum theory or the difficulties connected with it. Certain aspects of the difficulties were discussed in the presidential address before this Association by Sir Oliver Lodge at Birmingham in 1913. It suffices to say that this theory has proved of great value in several branches of science, and is supported by a large mass of direct experimental evidence.

In applying the quantum theory to the structure of the hydrogen atom Bohr supposed that the single electron could move in a number of stable orbits, controlled by the attractive force of the nucleus, without losing energy by radiation. The position and character of these orbits were defined by certain quantum relations depending on one or more whole numbers. It was assumed that radiation was only emitted when the electron for some reason was transferred from one stable orbit to another of lower energy. In such a case it was supposed that a homogeneous radiation was emitted of frequency ν determined by the quantum relation $E = h\nu$ where E was the difference of the energy of the electron in the two orbits. Some of these possible orbits are circular, others elliptical, with the nucleus as a focus, while if the change of mass of the electron with velocity is taken into account the orbits, as Sommerfeld showed, depend on two quantum numbers, and are not closed, but consist of a nearly elliptical orbit slowly rotating round the nucleus. In this way it is possible not only to account for the series relations between the bright lines of the hydrogen spectrum, but also to explain the

fine structure of the lines and the very complicated changes observed when the radiating atoms are exposed in a strong magnetic or electric field. Under ordinary conditions the electron in the hydrogen atom rotates in a circular orbit close to the nucleus, but if the atoms are excited by an electric discharge or other suitable method, the electron may be displaced and occupy any one of the stable positions specified by the theory. In a radiating gas giving the complete hydrogen spectrum there will be present many different kinds of hydrogen atoms, in each of which the electron describes one of the possible orbits specified by the theory. On this view it is seen that the variety of modes of vibration of the hydrogen atom is ascribed, not to complexity of the structure of the atom, but to the variety of stable orbits which an electron may occupy relative to the nucleus. This novel theory of the origin of spectra has been developed so as to apply not to hydrogen alone but to all the elements, and has been instrumental in throwing a flood of light on the relations and origin of their spectra, both X-ray and optical. The information thus gained has been applied by Bohr to determine the distribution of the electrons round the nucleus of any atom. The problem is obviously much less complicated for hydrogen than for a heavy atom, where each of the large number of electrons present acts on the other, and where the orbits described are much more intricate than the orbit of the single electron in hydrogen. Notwithstanding the great difficulties of such a complicated system of electrons in motion, it has been possible to fix the quantum numbers that characterise the motion of each electron, and to form at any rate a rough idea of the character of the orbit.

These planetary electrons divide themselves up into groups, according as their orbits are characterised by one or more equal quantum numbers. Without going into detail a few examples may be given to illustrate the conclusions which have been reached. As we have seen, the first element, hydrogen, has a nuclear charge of 1 and 1 electron; the second, helium, has a charge 2 and 2 electrons, moving in coupled orbits on the detailed nature of which there is still some uncertainty. These two electrons form a definite group, known as the K group, which is common to all the elements except hydrogen. For increasing nuclear charge the K group of electrons retains its characteristics, but moves with increasing speed, and approaches closer to the nucleus. As we pass from helium of atomic number 2 to neon, number 10, a new group of electrons is added consisting of two sub-groups, each of four electrons, together called the L group. This L group appears in all atoms of higher atomic number, and, as in the case of the K group, the speed of motion of the electrons increases, and the size of their orbits diminishes with the atomic number. When once the L group has been completed a new and still more complicated M group of electrons begins forming outside it, and a similar process goes on until uranium, which has the highest atomic number, is reached.

It may be of interest to try to visualise the conception of the atom we have so far reached by taking for illustration the heaviest atom, uranium. At the centre of the atom is a minute nucleus surrounded by a swirling group of 92 electrons, all in motion in definite orbits, and occupying but by no means filling a volume very large compared with that of the nucleus. Some of the electrons describe nearly circular orbits round the nucleus; others, orbits of a more elliptical shape with axes rotating rapidly round the nucleus. The motion of the electrons in the different groups is not necessarily confined to a definite region of the atom, but the electrons of one group may penetrate deeply into the region mainly occupied by another group, thus giving a type of inter-connexion or coupling between the various groups. The maximum speed of any electron depends on the closeness of the approach to the nucleus, but the outermost electron will have a minimum speed of more than 1000 kilometres per second, while the innermost K electrons have an average speed of more than 150,000 kilometres per second, or half the speed of light. When we visualise the extraordinary complexity of the electronic system we may be surprised that it has been possible to find any order in the apparent medley of motions.

In reaching these conclusions, which we owe largely to Prof. Bohr and his co-workers, every available kind of data about the different atoms has been taken into consideration. A study of the X-ray spectra, in particular, affords information of great value as to the arrangement of the various groups in the atom, while the optical spectrum and general chemical properties are of great importance in deciding the arrangements of the superficial electrons. While the solution of the grouping of the electrons proposed by Bohr has been assisted by considerations of this kind, it is not empirical in character, but has been largely based on general theoretical considerations of the orbits of electrons that are physically possible on the generalised quantum theory. The real problem involved may be illustrated in the following way. Suppose the gold nucleus be in some way stripped of its attendant seventy-nine electrons and that the atom is reconstituted by the successive addition of electrons one by one. According to Bohr, the atom will be reorganised in one way only, and one group after another will successively form and be filled up in the manner outlined. The nucleus atom has often been likened to a solar system where the sun corresponds to the nucleus and the planets to the electrons. The analogy, however, must not be pressed too far. Suppose, for example, we imagined that some large and swift celestial visitor traverses and escapes from our solar system without any catastrophe to itself or the planets. There will inevitably result permanent changes in the lengths of the month and year, and our system will never return to its original state. Contrast this with the effect of shooting an electron or α-particle through the electronic structure of the atom. The motion of many of the electrons will be disturbed by its passage, and in special cases an electron may be removed from its orbit and hurled out of its atomic system. In a short time another electron will fall into the vacant place from one of the outer groups, and this vacant place in turn will be filled up, and so on until the atom is again reorganised. In all cases the final state of the electronic system is the same as in the beginning. This illustration also serves to indicate the origin of the X-rays excited in the atom, for these arise in the process of re-formation of an atom from which an electron has been ejected, and the radiation

of highest frequency arises when the electron is removed from the K group.

It is possibly too soon to express a final opinion on the accuracy of this theory which defines the outer structure of the atom, but there can be no doubt that it constitutes a great advance. Not only does it offer a general explanation of the optical and X-ray spectra of the atom, but it accounts in detail for many of the most characteristic features of the periodic law of Mendeléeff. It gives us for the first time a clear idea of the reason for the appearance in the family of elements of groups of consecutive elements with similar chemical properties, such as the groups analogous to the iron group and the unique group of rare earths. The theory of Bohr, like all living theories, has not only correlated a multitude of isolated facts known about the atom, but has shown its power to predict new relations which can be verified by experiment. For example, the theory predicted the relations which must subsist between the Rydberg constants of the arc and spark spectra, and generally between all the successive optical spectra of an element, a prediction so strikingly confirmed by Paschen's work on the spectrum of doubly ionised aluminium and Fowler's work on the spectrum of trebly ionised silicon. Finally, it predicted with such great confidence the chemical properties of the missing element, number 72, that it gave the necessary incentive for its recent discovery.

While the progress of our knowledge of the outer structure of atoms has been much more rapid than could have been anticipated, we clearly see that only a beginning has been made on this great problem, and that an enormous amount of work is still required before we can hope to form anything like a complete picture even of the outer structure of the atom. We may be confident that the main features of the structure are clear, but in a problem of such great complexity progress in detail must of necessity be difficult and slow.

We have not so far referred to the very difficult question of the explanation on this theory of the chemical combination of atoms. In fact, as yet the theory has scarcely concerned itself with molecular structure. On the chemical side, however, certain advances have already been made, notably by G. N. Lewis, Kossel, and Langmuir, in the interpretation of the chemical evidence by the idea of shared electrons, which play a part in the electronic structure of two combined atoms. There can be little doubt that the next decade will see an intensified attack by physicists and chemists on this very important but undoubtedly very complicated question.

Before leaving this subject, it may be of interest to refer to certain points in Bohr's theory of a more philosophical nature. It is seen that the orbits and energies of the various groups of electrons can be specified by certain quantum numbers, and the nature of the radiation associated with a change of orbit can be defined. But at the same time we cannot explain why these orbits are alone permissible under normal conditions, or understand the mechanism by which radiation is emitted. It may be quite possible to formulate accurately the energy relation of the electrons in the atom on a simple theory, and to explain in considerable detail all the properties of an atom, without any clear understanding of the underlying processes which lead to these results. It is natural to hope that with advance of knowledge we may be able to grasp the details of the process which leads to the emission of radiation, and to understand why the orbits of the electrons in the atom are defined by the quantum relations. Some, however, are inclined to take the view that in the present state of knowledge it may be quite impossible in the nature of things to form that detailed picture in space and time of successive events that we have been accustomed to consider as so important a part of a complete theory. The atom is naturally the most fundamental structure presented to us. Its properties must explain the properties of all more complicated structures, including matter in bulk, but we may not, therefore, be justified in expecting that its processes can be explained in terms of concepts derived entirely from a study of molar properties. The atomic processes involved may be so fundamental that a complete understanding may be denied us. It is early yet to be pessimistic on this question, for we may hope that our difficulties may any day be resolved by further discoveries.

We must now turn our attention to that new and comparatively unexplored territory, the nucleus of the atom. In a discussion on the structure of the atom ten years ago, in answer to a question on the structure of the nucleus, I was rash enough to say that it was a problem that might well be left to the next generation, for at that time there seemed to be few obvious methods of attack to throw light on its constitution. While much more progress has been made than appeared possible at that time, the problem of the structure of the nucleus is inherently more difficult than the allied problem already considered of the structure of the outer atom, where we have a wealth of information obtained from the study of light and X-ray spectra and from the chemical properties to test the accuracy of our theories.

In the case of the nucleus, we know its resultant charge, fixed by Moseley's law, and its mass, which is very nearly equal to the mass of the whole atom, since the mass of the planetary electrons is relatively very small and may for most purposes be neglected. We know that the nucleus is of size minute compared with that of the whole atom, and can with some confidence set a maximum limit to its size. The study of radioactive bodies has provided us with very valuable information on the structure of the nucleus, for we know that the α- and β-particles must be expelled from it, and there is strong evidence that the very penetrating γ-rays represent modes of vibration of the electrons contained in its structure. In the long series of transformations which occur in the uranium atom, eight α-particles are emitted and six electrons, and it seems clear that the nucleus of a heavy atom is built up, in part at least, of helium nuclei and electrons. It is natural to suppose that many of the ordinary stable atoms are constituted in a similar way. It is a matter of remark that no indication has been obtained that the lightest nucleus, namely, that of hydrogen, is liberated in these transformations, where the processes occurring are of so fundamental a character. At the same time, it is evident that the hydrogen nucleus must be a unit in the structure of some atoms,

and this has been confirmed by direct experiment. Dr. Chadwick and I have observed that swift hydrogen nuclei are released from the elements boron, nitrogen, fluorine, sodium, aluminium, and phosphorus when they are bombarded by swift α-particles, and there is little room for doubt that these hydrogen nuclei form an essential part of the nuclear structure. The speed of ejection of these nuclei depends on the velocity of the α-particle and on the element bombarded. It is of interest to note that the hydrogen nuclei are liberated in all directions, but the speed in the backward direction is always somewhat less than in the direction of the α-particle. Such a result receives a simple explanation if we suppose that the hydrogen nuclei are not built into the main nucleus but exist as satellites probably in motion round a central core. There can be no doubt that bombardment by α-particles has effected a veritable disintegration of the nuclei of this group of elements. It is significant that the liberation of hydrogen nuclei only occurs in elements of odd atomic number, namely, 5, 7, 9, 11, 13, 15, the elements of even number appearing quite unaffected. For a collision of an α-particle to be effective, it must either pass close to the nucleus or actually penetrate its structure. The chance of this is excessively small on account of the minute size of the nucleus. For example, although each individual α-particle will pass through the outer structure of more than 100,000 atoms of aluminium in its path, it is only about one α-particle in a million that gets close enough to the nucleus to effect the liberation of its hydrogen satellite.

This artificial disintegration of elements by α-particles takes place only on a minute scale, and its observation has only been possible by the counting of individual swift hydrogen nuclei by the scintillations they produce in zinc sulphide.

These experiments suggest that the hydrogen nucleus or proton must be one of the fundamental units which build up a nucleus, and it seems highly probable that the helium nucleus is a secondary building unit composed of the very close union of four protons and two electrons. The view that the nuclei of all atoms are ultimately built up of protons of mass nearly one and of electrons has been strongly supported and extended by the study of isotopes. It was early observed that some of the radioactive elements which showed distinct radioactive properties were chemically so alike that it was impossible to effect their separation when mixed together. Similar elements of this kind were called "isotopes" by Soddy, since they appeared to occupy the same place in the periodic table. For example, a number of radioactive elements in the uranium and thorium series have been found to have physical and chemical properties identical with those of ordinary lead, but yet to have atomic weights differing from ordinary lead, and also distinctive radioactive properties. The nuclear theory of the atom offers at once a simple interpretation of the relation between isotopic elements. Since the chemical properties of an element are controlled by its nuclear charge and little influenced by its mass, isotopes must correspond to atoms with the same nuclear charge but of different nuclear mass. Such a view also offers a simple explanation why the radioactive isotopes show different radioactive properties, for it is to be anticipated that the stability of a nucleus will be much influenced by its mass and arrangement.

Our knowledge of isotopes has been widely extended in the last few years by Aston, who has devised an accurate direct method for showing the presence of isotopes in the ordinary elements. He has found that some of the elements are "pure"—*i.e.* consist of atoms of identical mass—while others contain a mixture of two or more isotopes. In the case of the isotopic elements, the atomic mass, as ordinarily measured by the chemist, is a mean value depending on the atomic masses of the individual isotopes and their relative abundance. These investigations have not only shown clearly that the number of distinct species of atoms is much greater than was supposed, but have also brought out a relation between the elements of great interest and importance. The atomic masses of the isotopes of most of the elements examined have been found, to an accuracy of about one in a thousand, to be whole numbers in terms of oxygen, 16. This indicates that the nuclei are ultimately built up of protons of mass very nearly 1 and of electrons. It is natural to suppose that this building unit is the hydrogen nucleus, but that its average mass in the complex nucleus is somewhat less than its mass in the free state owing to the close packing of the charged units in the nuclear structure. We have already seen that the helium nucleus of mass 4 is probably a secondary unit of great importance in the building up of many atoms, and it may be that other simple combinations of protons and electrons of mass 2 and 3 occur in the nucleus, but these have not been observed in the free state.

While the mass of the majority of the isotopes are nearly whole numbers, certain cases have been observed by Aston where this rule is slightly departed from. Such variations in mass may ultimately prove of great importance in throwing light on the arrangement and closeness of packing of the protons and electrons, and for this reason it is to be hoped that it may soon prove possible to compare atomic masses of the elements with much greater precision even than at present.

While we may be confident that the proton and the electron are the ultimate units which take part in the building up of all nuclei, and can deduce with some certainty the number of protons and electrons in the nuclei of all atoms, we have little, if any, information on the distribution of these units in the atom or on the nature of the forces that hold them in equilibrium. While it is known that the law of the inverse square holds for the electrical forces some distance from the nucleus, it seems certain that this law breaks down inside the nucleus. A detailed study of the collisions between α-particles and hydrogen atoms, where the nuclei approach very close to each other, shows that the forces between nuclei increase ultimately much more rapidly than is to be expected from the law of the inverse square, and it may be that new and unexpected forces may come into importance at the very small distances separating the protons and electrons in the nucleus. Until we gain more information on the nature and law of variation of the forces inside the nucleus, further progress on the detailed structure of the nucleus may be difficult. At the same time, there

are still a number of hopeful directions in which an attack may be made on this most difficult of problems. A detailed study of the γ-rays from radioactive bodies may be expected to yield information as to the motion of the electrons inside the nucleus, and it may be, as Ellis has suggested, that quantum laws are operative inside as well as outside the nucleus. From a study of the relative proportions of the elements in the earth's crust, Harkins has shown that elements of even atomic number are much more abundant than elements of odd number, suggesting a marked difference of stability in these two classes of elements. It seems probable that any process of stellar evolution must be intimately connected with the building up of complex nuclei from simpler ones, and its study may thus be expected to throw much light on the evolution of the elements.

The nucleus of a heavy atom is undoubtedly a very complicated system, and in a sense a world of its own, little, if at all, influenced by the ordinary physical and chemical agencies at our command. When we consider the mass of a nucleus compared with its volume it seems certain that its density is many billions of times that of our heaviest element. Yet, if we could form a magnified picture of the nucleus, we should expect that it would show a discontinuous structure, occupied but not filled by the minute building units, the protons and electrons, in ceaseless rapid motion controlled by their mutual forces.

Before leaving this subject it is desirable to say a few words on the important question of the energy relations involved in the formation and disintegration of atomic nuclei, first opened up by the study of radioactivity. For example, it is well known that the total evolution of energy during the complete disintegration of one gram of radium is many millions of times greater than in the complete combustion of an equal weight of coal. It is known that this energy is initially mostly emitted in the kinetic form of swift α- and β-particles, and the energy of motion of these bodies is ultimately converted into heat when they are stopped by matter. Since it is believed that the radioactive elements are analogous in structure to the ordinary inactive elements, the idea naturally arose that the atoms of all the elements contained a similar concentration of energy, which would be available for use if only some simple method could be discovered of promoting and controlling their disintegration. This possibility of obtaining new and cheap sources of energy for practical purposes was naturally an alluring prospect to the lay and scientific man alike. It is quite true that, if we were able to hasten the radioactive processes in uranium and thorium so that the whole cycle of their disintegration could be confined to a few days instead of being spread over thousands of millions of years, these elements would provide very convenient sources of energy on a sufficient scale to be of considerable practical importance. Unfortunately, although many experiments have been tried, there is no evidence that the rate of disintegration of these elements can be altered in the slightest degree by the most powerful laboratory agencies. With increase in our knowledge of atomic structure there has been a gradual change of our point of view on this important question, and there is by no means the same certainty to-day as a decade ago that the atoms of an element contain hidden stores of energy. It may be worth while to spend a few minutes in discussing the reason for this change in outlook. This can best be illustrated by considering an interesting analogy between the transformation of a radioactive nucleus and the changes in the electron arrangement of an ordinary atom. It is now well known that it is possible by means of electron bombardment or by appropriate radiation to excite an atom in such a way that one of its superficial electrons is displaced from its ordinary stable position to another temporarily stable position further removed from the nucleus. This electron in course of time falls back into its old position, and its potential energy is converted into radiation in the process. There is some reason for believing that the electron has a definite average life in the displaced position, and that the chance of its return to its original position is governed by the laws of probability. In some respects an "excited" atom of this kind is thus analogous to a radioactive atom, but of course the energy released in the disintegration of a nucleus is of an entirely different order of magnitude from the energy released by return of the electron in the excited atom. It may be that the elements, uranium and thorium, represent the sole survivals in the earth to-day of types of elements that were common in the long-distant ages, when the atoms now composing the earth were in course of formation. A fraction of the atoms of uranium and thorium formed at that time has survived over the long interval on account of their very slow rate of transformation. It is thus possible to regard these atoms as having not yet completed the cycle of changes which the ordinary atoms have long since passed through, and that the atoms are still in the "excited" state where the nuclear units have not yet arranged themselves in positions of ultimate equilibrium, but still have a surplus of energy which can only be released in the form of the characteristic radiation from active matter. On such a view, the presence of a store of energy ready for release is not a property of all atoms, but only of a special class of atoms like the radioactive atoms which have not yet reached the final state for equilibrium.

It may be urged that the artificial disintegration of certain elements by bombardment with swift α-particles gives definite evidence of a store of energy in some of the ordinary elements, for it is known that a few of the hydrogen nuclei, released from aluminium for example, are expelled with such swiftness that the particle has a greater individual energy than the α-particle which causes their liberation. Unfortunately, it is very difficult to give a definite answer on this point until we know more of the details of this disintegration.

On the other hand, another method of attack on this question has become important during the last few years, based on the comparison of the relative masses of the elements. This new point of view can best be illustrated by a comparison of the atomic masses of hydrogen and helium. As we have seen, it seems very probable that helium is not an ultimate unit in the structure of nuclei, but is a very close combination of four hydrogen nuclei and two electrons. The mass of the helium nucleus, 4·00 in terms of $O=16$, is considerably less than the mass, 4·03, of four hydrogen nuclei. On modern views there is believed to be a very

close connexion between mass and energy, and this loss in mass in the synthesis of the helium nucleus from hydrogen nuclei indicates that a large amount of energy in the form of radiation has been released in the building of the helium nucleus from its components. It is easy to calculate from this loss of mass that the energy set free in forming one gram of helium is large even compared with that liberated in the total disintegration of one gram of radium. For example, calculation shows that the energy released in the formation of one pound of helium gas is equivalent to the energy emitted in the complete combustion of about eight thousand tons of pure carbon. It has been suggested by Eddington and Perrin that it is mainly to this source of energy that we must look to maintain the heat emission of the sun and hot stars over long periods of time. Calculations of the loss of heat from the sun show that this synthesis of helium need only take place slowly in order to maintain the present rate of radiation for periods of the order of one thousand million years. It must be acknowledged that these arguments are somewhat speculative in character, for no certain experimental evidence has yet been obtained that helium can be formed from hydrogen.

The evidence of the slow rate of stellar evolution, however, certainly indicates that the synthesis of helium, and perhaps other elements of higher atomic weight, may take place slowly in the interior of hot stars. While in the electric discharge through hydrogen at low pressure we can easily reproduce the conditions of the interior of the hottest star so far as regards the energy of motion of the electrons and hydrogen nuclei, we cannot hope to reproduce that enormous density of radiation which must exist in the interior of a giant star. For this and other reasons it may be very difficult, or even impossible, to produce helium from hydrogen under laboratory conditions.

If this view of the great heat emission in the formation of helium be correct, it is clear that the helium nucleus is the most stable of all nuclei, for an amount of energy corresponding to three or four α-particles would be required to disrupt it into its components. In addition, since the mass of the proton in nuclei is nearly 1·000 instead of its mass 1·0072 in the free state, it follows that much more energy must be put into the atom than will be liberated by its disintegration into its ultimate units. At the same time, if we consider an atom of oxygen, which may be supposed to be built up of four helium nuclei as secondary units, the change of mass, if any, in its synthesis from already formed helium nuclei is so small that we cannot yet be certain whether there will be a gain or loss of energy by its disintegration into helium nuclei, but in any case we are certain that the magnitude of the energy will be much less than for the synthesis of helium from hydrogen. Our information on this subject of energy changes in the formation or disintegration of atoms in general is as yet too uncertain and speculative to give any decided opinion on future possibilities in this direction, but I have endeavoured to outline some of the main arguments which should be taken into account.

I must now bring to an end my survey, I am afraid all too brief and inadequate, of this great period of advance in physical science. In the short time at my disposal it has been impossible for me, even if I had the knowledge, to refer to the great advances made during the period under consideration in all branches of pure and applied science. I am well aware that in some departments the progress made may justly compare with that of my own subject. In these great additions to our knowledge of the structure of matter every civilised nation has taken an active part, but we may be justly proud that Great Britain has made many fundamental contributions. With this country I must properly include the Dominions overseas, for they have not been behindhand in their contributions to this new knowledge. It is, I am sure, a matter of pride to this country that the scientific men of the Dominions have been responsible for some of the most fundamental discoveries of this epoch, particularly in radioactivity.

This tide of advance was continuous from 1896, but there was an inevitable slackening during the War. It is a matter of good omen that, in the last few years, the old rate of progress has not only been maintained but even intensified, and there appears to be no obvious sign that this period of great advances has come to an end. There has never been a time when the enthusiasm of the scientific workers was greater, or when there was a more hopeful feeling that great advances were imminent. This feeling is no doubt in part due to the great improvement during this epoch of the technical methods of attack, for problems that at one time seemed unattackable are now seen to be likely to fall before the new methods. In the main, the epoch under consideration has been an age of experiment, where the experimenter has been the pioneer in the attack on new problems. At the same time, it has been also an age of bold ideas in theory, as the quantum theory and the theory of relativity so well illustrate.

I feel it is a great privilege to have witnessed this period, which may almost be termed the renaissance of physics. It has been of extraordinary intellectual interest to watch the gradual unfolding of new ideas and the ever-changing methods of attack on difficult problems. It has been of great interest, too, to note the comparative simplicity of the ideas that have ultimately emerged. For example, no one could have anticipated that the general relation between the elements would prove to be of so simple a character as we now believe it to be. It is an illustration of the fact that Nature appears to work in a simple way, and that the more fundamental the problem, often the simpler are the conceptions needed for its explanation. The rapidity and certitude of the advance in this epoch have largely depended on the fact that it has been possible to devise experiments so that few variables were involved. For example, the study of the structure of the atom has been much facilitated by the possibility of examining the effects due to a single atom of matter, or, as in radioactivity or X-rays, of studying processes going on in the individual atom which were quite uninfluenced by external conditions.

In watching the rapidity of this tide of advance in physics I have become more and more impressed by the power of the scientific method of extending our knowledge of Nature. Experiment, directed by the disciplined imagination either of an individual, or still better, of a group of individuals of varied mental

outlook, is able to achieve results which far transcend the imagination alone of the greatest natural philosopher. Experiment without imagination, or imagination without recourse to experiment, can accomplish little, but, for effective progress, a happy blend of these two powers is necessary. The unknown appears as a dense mist before the eyes of men. In penetrating this obscurity we cannot invoke the aid of supermen, but must depend on the combined efforts of a number of adequately trained ordinary men of scientific imagination. Each in his own special field of inquiry is enabled by the scientific method to penetrate a short distance, and his work reacts upon and influences the whole body of other workers. From time to time there arises an illuminating conception, based on accumulated knowledge, which lights up a large region and shows the connexion between these individual efforts so that a general advance follows. The attack begins anew on a wider front, and often with improved technical weapons. The conception which led to this advance often appears simple and obvious when once it has been put forward. This is a common experience, and the scientific man often feels a sense of disappointment that he himself had not foreseen a development which ultimately seems so clear and inevitable.

The intellectual interest due to the rapid growth of science to-day cannot fail to act as a stimulus to young men to join in scientific investigation. In every branch of science there are numerous problems of fundamental interest and importance which await solution. We may confidently predict an accelerated rate of progress of scientific discovery, beneficial to mankind certainly in a material, but possibly even more so in an intellectual sense. In order to obtain the best results, certain conditions must, however, be fulfilled. It is necessary that our universities and other specific institutions should be liberally supported, so as not only to be in a position to train adequately young investigators of promise, but also to serve themselves as active centres of research. At the same time there must be a reasonable competence for those who have shown a capacity for original investigation. Not least, peace throughout the civilised world is as important for rapid scientific development as for general commercial prosperity. Indeed, science is truly international, and for progress in many directions the co-operation of nations is as essential as the co-operation of individuals. Science, no less than industry, desires a stability not yet achieved in world conditions.

There is an error far too prevalent to-day that science progresses by the demolition of former well-established theories. Such is very rarely the case. For example, it is often stated that Einstein's general theory of relativity has overthrown the work of Newton on gravitation. No statement could be further from the truth. Their works, in fact, are scarcely comparable, for they deal with different fields of thought. So far as the work of Einstein is relevant to that of Newton, it is simply a generalisation and broadening of its basis; in fact, a typical case of mathematical and physical development. In general, a great principle is not discarded, but so modified that it rests on a broader and more stable basis.

It is clear that the splendid period of scientific activity which we have here reviewed owes much of its success and intellectual appeal to the labours of those great men in the past, who wisely laid the sure foundations on which the scientific worker builds to-day, or to quote from the words inscribed in the dome of the National Gallery, "The works of those who have stood the test of ages have a claim to that respect and veneration to which no modern can pretend."

Scientific Problems and Progress.[1]

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS OF THE BRITISH ASSOCIATION.

THE ORIGIN OF SPECTRA.

THE focus of Prof. McLennan's remarks in his presidential address to Section A (Mathematics and Physics), to be delivered on September 17, is Bohr's theory of the origin of radiation and of atomic structure. Evidence in support of the theory is drawn largely from recent researches on the spectra of the elements.

Among the subjects discussed are the significance of the fine structure of the spectral lines of hydrogen and the recent attempts to devise a model of the helium atom capable of accounting for the characteristics of the helium spectrum.

In dealing with the question of the genesis of atoms of various types, illustrations are given of the view recently put forward by Bohr that the fundamental process that must apply consists in the successive binding of electrons by a nucleus originally naked. Bohr's scheme of electronic orbits for the atoms of different elements provides a means of establishing a connexion between spectral series formulæ of different types and the energy levels in atoms and, also, of deducing the values of resonance and ionisation potentials, hitherto undetermined, for a number of elements. Special attention is paid to the elements of the lead-tin and chromium-manganese groups.

A number of illustrations are given of the Kossel-Sommerfeld Displacement Law, and the importance of the recent work of Fowler and of Paschen in this connexion is emphasised. Spectroscopic data, recently obtained, that are likely to lead to extensions of this work are also discussed.

In dealing with the magnetic properties of certain contiguous elements, anomalies are referred to that apparently do not find so ready an explanation with Bohr's scheme of electronic orbits for the atoms of successive elements as the Kossel-Sommerfeld Displacement Law. Reference is also made to the principle of quantisation in space recently brought into prominence by the interesting experiments of Gerlach and Stern and by the work of R. W. Wood and Ellett.

[1] All the presidential addresses are published in full in "The Advancement of Science: 1923" (London: John Murray).

This latter, it will be recalled, deals with the power possessed by weak magnetic fields of modifying the capability shown by the vapours of mercury and sodium of polarising radiation scattered by them.

The adiabatic hypothesis enunciated by Ehrenfest is discussed, and also the use of this principle in conjunction with the quantum theory in elucidating Zeeman effects of the normal type. Reference is made, as well, to the interesting and suggestive attempts of Heisenberg and Sommerfeld to find in a development of the quantum theory an explanation of the anomalous Zeeman effect exhibited by certain classes of spectral lines. In this application of the quantum theory it is assumed that the doublet separations characteristic of series such as those of the arc spectra of the alkali elements are in reality Zeeman separations produced by intra-atomic magnetic fields. In conclusion there are illustrations of the magnitude of such intra-atomic magnetic fields, and a discussion of some of the difficulties raised by Heisenberg and Sommerfeld's theory and of some objections in the way of its immediate and general acceptance.

Physical Chemistry of Surfaces.

The subjects dealt with by Prof. F. G. Donnan, in his address to Section B (Chemistry) are principally molecular orientation and molecular dimensions at surfaces and in surface films, molecular concentration at surfaces and its effect on surface tension, electrical potential differences at surfaces, stabilities of foams, oil suspensions, lyophobic hydrosols, and oil emulsions. The surfaces especially considered are the liquid-gas and liquid-liquid surfaces. The researches of W. B. Hardy have led to the conception of surface layers of oriented molecules, as the result of unsymmetrical fields of force surrounding molecules, due to the presence of active atoms or atomic groups. The views of Hardy have been confirmed by the work of W. D. Harkins and his collaborators.

The study of *unimolecular* surface layers of insoluble substances on the surface of water, initiated by the late Lord Rayleigh and developed by H. Devaux and A. Marcelin, has led in the hands of I. Langmuir and N. K. Adam to the determination of molecular and atomic dimensions. Certain recent investigations by X-ray methods have an interesting bearing on these results.

Unimolecular layers may also be formed by the adsorption of vapours on liquid and solid surfaces. Dissolved substances which lower the surface tension of a gas-liquid or liquid-liquid interface concentrate at these interfaces. Do they form unimolecular layers?

Electric potential differences exist at the gas-liquid, liquid-liquid, and solid-liquid interfaces. These potential differences are affected by "surface-active" substances, by ions, colloidal micelles, etc. The potential differences determine the stabilities of oil suspensions and lyophobic hydrosols. The "critical" potential differences and the "critical zone" of potential difference are of importance in such cases.

The formation of concentrated surface layers and surface films plays an important rôle in the production and stabilisation of emulsions. Surface actions are of importance in biological phenomena. The existence and activity of the living organism are dynamic and depend on an environment which is not in equilibrium. The living organism is an *individual*. Further progress will depend on the study of the particular actions of individuals rather than the average behaviour of "crowds."

Evolutional Palæontology.

The presidential address by Dr. Gertrude Elles to Section C (Geology) is on the subject of "Evolutional Palæontology in Relation to the Lower Palæozoic Rocks." The problems of the Lower Palæozoic Rocks still awaiting solution are in the main those of classification and structure, which are largely interdependent. The most satisfactory solution appears to lie in the application of the principles of evolutional palæontology. The most effective modern classification of strata is that based upon the coming in of new forms of life, but if it is to be of wide application this must not be connected directly with changes in the character of the sedimentation.

The variation in the nature of shallow-water faunas due to various factors such as temperature, salinity, and clearness of the water, is illustrated by reference to the recent work at the Danish Biological Station; the classification and correlation of such deposits must be a matter of great difficulty unless a common principle can be introduced. The standard for purposes of classification must be sought in the faunas of the deeper waters of the Lower Palæozoic seas, where the changes in the fauna show primarily as an advance in the evolutional stage of the organisms concerned. The various shallow-water deposits should be referred to those of deeper-water origin when possible, or the relative ages may to some extent be determined by noting the evolutional stage reached by various organisms composing the faunas.

These principles are illustrated by a study of the evolution of the Graptoloidea as the characteristic fauna of the deeper-water sediments of the Lower Palæozoic, and it is shown that important evolutional stages are characteristic of definite geological horizons, these being recognisable without any knowledge of the various Graptolite species. In the faunas of the shallower-waters the evolution of certain features in some species-groups of the Trilobita are described and the horizons at which these occur are noted. Mention is made of the work already published on other fossil phyla, and attention is especially directed to that of various observers on the evolution of the corals in the Carboniferous as the type of work to be aimed at in the future in the Lower Palæozoic Rocks.

The old purely descriptive work so often carried out entirely in the museum or laboratory must give place to that in which fossils are regarded as parts of once-living entities possessing definite ancestors and descendants developing along definite lines, the relationships of these being controlled always by field work.

Zoology and its Human Aspects.

Prof. Ashworth devoted the first part of his address to Section D (Zoology), on September 13, to a brief retrospective glance over some of the lines of development in zoology since the last meeting in

Liverpool. He referred to the rapid extension of physiological methods of inquiry to the lower organisms, the discovery of artificial parthenogenesis, the intensive study of egg-cleavage, cell-lineage, and the maturation of the egg and sperm, the remarkable progress of cytology, and to researches on the structural basis of heredity and on the nuclear mechanism correlated with sex. Other subjects discussed were the study of the finer structure of the nerve-cell and its processes and of the neuromotor system of the Protozoa, the investigations on the ciliate Protozoa, especially on Paramæcium, with the purpose of ascertaining whether decline and death depend on inherent factors or on external conditions, and the researches on the culture of tissues, which are leading to a knowledge of the conditions which determine the growth and differentiation of somatic cells.

In the second part of the address some of the bearings of zoology on human welfare were considered. At the time of the last meeting in Liverpool insects were suspected of acting as transmitters of certain pathogenic organisms to man, but these cases were few and in no single instance had the life-cycle of the organism been worked out and the mode of transmission from insect to man ascertained. The part played by the mosquito as host and transmitter of the parasite of malaria was made known by Ross nearly two years after that meeting. Of the ten important examples of arthropods now proved to act as carriers of pathogenic organisms to man, Prof. Ashworth chose three for consideration, namely, Stegomyia and yellow fever, tsetse-flies and sleeping-sickness, and the flea *Xenopsylla cheopis* and plague, this last providing a fine illustration of the value of careful work on the systematics and on the structure and bionomics of the insect concerned. Intensive work on the Protozoa has been an outstanding feature during the last twenty-five years, and *Entamœba histolytica*, the organism of amœbic dysentery, was taken as an example of the importance of researches on Protozoa which directly affect man. Of the notable investigations on parasitic worms, reference was made to the great advances in our knowledge of the life-history and bionomics of Ancylostoma and of Schistosoma (Bilharzia), which have enabled effective measures to be taken against infection by these parasites.

In conclusion, Prof. Ashworth referred to the place and value of zoology in the medical curriculum, gave an outline of the subjects which he considered should be included in the course of zoology for medical students, and invited discussion on this part of the address.

The British Empire as a Maritime State.

The subject of Dr. Vaughan Cornish's presidential address to Section E (Geography) is the "Geographical Position of the British Empire." It may be thought that an Empire on which the sun never sets, with lands in both hemispheres and on every continent, cannot be assigned a place upon the map, and in fact so long as it is regarded from the continental point of view it cannot be given a definite geographical position. It is, however, a maritime State, the metropolitan and other provinces being united by ocean routes on which lie British ports of call which can be used as naval stations, but separated strategically by those parts of the ocean which are not so provided, and are readily dominated from the ports of other Great Powers. An examination of these conditions shows that, taking account only of the communications which are available in all circumstances, the lands of the British Empire are connected by the Atlantic and Indian, separated by the North Pacific Ocean. Hence the geographical position of the Empire is well represented by the form of Mercator map in which the meridian of Greenwich is central and the right- and left-hand edges are at longitude 180°. The Empire thus appears astride the North Atlantic and the Indian Ocean, but with its Pacific shores unconnected.

A symmetrical arrangement is revealed upon this map if a direct line (part of a great circle) be drawn from Halifax, Nova Scotia, the eastern terminal of the Canadian Pacific Railway, to Fremantle, the western terminal port of the Australian railways. This direct line (twisted on the map into the form of the letter S) passes through Lower Egypt close to the Suez Canal, which is not very far from its middle point. It follows somewhat closely the main steamship track of the Empire. At one end is Canada, at the other Australasia, the British Isles on the north and South Africa on the south. The coloured populations of the Empire are also distributed symmetrically with reference to the line, those of India on the east, of Africa on the west, so that the great circle from Halifax, N.S., eastwards to Fremantle is the geometrical axis of the Empire.

The Empire as thus mapped can be shown to have an intermediate position on the present commercial and international communications of the world such as no other Great Power occupies, so that the British, in a greater degree than any other people, are the doorkeepers of the world.

The consolidation of the position turns on the future of colonisation during the time which remains before the untilled lands of the world are occupied by peasantry. In the second part of the address the present tendency of this movement is traced both among coloured and white peoples, and special attention is given to the question, now so much debated, whether a surplus of birth-rate over death-rate in Great Britain is, or is not, in the interests of the country, of the peoples of the Empire, and of mankind.

Population and Unemployment.

The common impression that Europe is already threatened with over-population may be traced to two sources—to observation of the exceptional volume of unemployment to-day, and to the words of certain economists describing Europe before the War. Sir William Beveridge deals with these subjects in his presidential address to be given to Section F (Economics) on Monday, September 17. Unemployment does not necessarily or naturally point to excessive growth of population; severe and prolonged unemployment has occurred at times and in countries which were certainly not marked by over-population. Statements such as those of Mr. Keynes, that Europe was over-populated even before the War, appear ill-founded; in Europe, no less than in the New World, the yield of corn

per acre and per head of the population was rising, not falling; the price of corn relatively to other commodities was falling, not rising, up to the eve of War. There is still room for the expansion of the white races. In Britain, as distinct from Europe as a whole, the rate of material progress which marked the Victorian age was not maintained from 1900 to 1910; this apparent check, however, may have been temporary and due to special causes.

In considering the position of Britain after the War, the example of German Austria, a highly specialised and advanced community depending on free trade over a large and varied area, is apposite. The optimum density of population in any given region depends, not on that region alone, but also on the economic conditions and needs of the rest of the world. A decline of international dealing hurts all, but most of all the highly specialised communities typified by German Austria and Britain. The suggestion that we should avoid the "Austrian risk" in future by aiming at self-sufficiency is not practical. Britain, as we know it, and with anything like its present population, depends upon peace and trade. Its excessive unemployment to-day can be fully explained by the War and its aftermath of economic disorganisation, and the remedy must be sought elsewhere than in birth control.

Though, however, increased birth control is not required by the conditions of Europe before the War and is irrelevant to its present troubles, the problem of numbers has to be faced. Man cannot with safety indefinitely reduce the death-rate and leave the birth-rate to look after itself; as a matter of history, he has at almost all stages of his development limited the number of his descendants. The problem of population is, at the moment, a matter for suspension of judgment and inquiry. Two inquiries in particular are suggested: one, into the potential agricultural resources of the world, analogous to the inquiries made at various times as to coal; the other, into the physical, psychological, and social effects of the restriction of fertility which has become general among European races in the past fifty years.

Transport and its Debt to Science.

Sir Henry Fowler's address to Section G (Engineering) deals with the subject of transport and its indebtedness to science. Since its foundation the city of Liverpool has been associated with transport, and no town owes so much to the facilities to trade which transport has afforded, or has played so frequently the part of a pioneer in the inception of new methods. The Mersey and Trent Canal, the Manchester Ship Canal, the Rainhill Railway trials, the electrification of the Liverpool and Southport railway, and the Commercial Motor Trials of the Liverpool Self-Propelled Traffic Association testify to this.

All advances in methods of transport have been the result of the availability of scientific knowledge. Since the time of Watt these advances have taken place when the "ordered knowledge of natural phenomena" has allowed. Progress has depended upon this knowledge; locomotive design benefited by the experiments of Schmidt; electric traction by the numberless researches into electrical phenomena, and the development of the turbine by Parsons: the work of the latter gave a fresh impulse to marine transport. The motor car and the aeroplane owe much to the Otto cycle and the work of Daimler on internal combustion engines. The above are the results of work on methods of propulsion. The advance in our knowledge of material has also played its part. Until the invention of Bessemer the material requisite was not available in quantities sufficient to allow of much progress being made. The early work of Hadfield on alloy steels has developed in such a manner that the motor car and the aeroplane are possible as we have them to-day. It is not alone in general and large questions that scientific knowledge has helped transport, but it can be shown that a careful investigation of the properties of the steel from which locomotive crank axles are made has led to a large increase in their life.

One great trouble with scientific development on industrial lines is the difficulty of obtaining correct results from practical application. The transport bodies have no axe to grind in the use of any particular thing, and should show their appreciation of their indebtedness to science by freely giving the results of their work.

Another trouble which still exists is that the personal contact of the scientific man and the practical engineer does not occur frequently enough, and the meetings of the Association should be more freely used for this purpose.

Egypt as a Field for Anthropological Research.

As the habits, modes of life, and occupations of all communities are immediately dependent upon the features and products of the land in which they dwell, any inquiry into Egyptian origins ought to begin with the question, What were the physical conditions which prevailed in Egypt and its bordering deserts in the period immediately preceding, and during the rise of, the Egyptian civilisation? Discussing what is actually known about the fauna and flora of the dynastic and predynastic periods, Prof. Newberry, in his presidential address to be delivered to Section H (Anthropology) on September 17, shows that a material change must have taken place in the character of the climate of North-Eastern Africa since pre-agricultural days. The fauna and flora have receded southwards, and the physical conditions which now prevail in the region north of the Atbara are similar to those which prevailed in the deserts on either side of the Lower Nile Valley in early times. The people living in this part of the Anglo-Egyptian Sudan are Hamite, and, as Prof. Seligman has shown, the least modified of these people are physically identical with the predynastic Egyptians of Upper Egypt. Prof. Newberry suggests that they, like the fauna and flora, have receded southwards under the pressure of the advance of civilisation, and that the physical conditions of the country have preserved them to a great extent in their primitive life and pursuits. The picture of life in the Taka country as drawn by Burckhardt in 1813 would, except in some unimportant details, equally well depict the predynastic Egyptians.

Prof. Newberry proceeds to show that the earliest

civilisation in Egypt arose in the Delta, and that it spread up the river. Before Menes conquered the north there had been a kingdom of Middle and Upper Egypt, and before that a kingdom with its capital at Sais in the North-Western Delta. The people of the North-Western Delta were closely connected with the early Cretans, and were of the same race as the pre-dynastic people of Upper Egypt. In the Eastern Delta at an early period lived a pastoral clan that had come in from Western Asia and brought into Egypt the domesticated goat and sheep, as well as two important cults connected with trees that were not indigenous to the soil of Egypt. The absence of timber trees makes it doubtful whether the art of the carpenter arose in the Nile Valley. Architectural styles founded on wood construction cannot well have originated in a timberless country, nor could the art of building sailing or sea-going ships. It may be doubted that the custom of burying the dead in wooden coffins arose in Egypt; the resins used in embalming were not native to the Nile Valley. No incense trees or shrubs are known in Egypt, hence it is probable that the ceremonial use of incense did not arise there. Such are some of the anthropological questions raised by a study of the flora of the Lower Nile Valley.

Symbiosis in Animals and Plants.

Prof. George H. F. Nuttall's address to Section I (Physiology) dealt with (1) Symbiosis in plants: lichens; root-nodules of leguminous plants; the significance of micorhiza in various plants, especially orchids; and (2) Symbiosis in animals: Algæ as symbionts in various animals; symbiosis in insects; micro-organisms in relation to luminescence in animals. The subject is one of broad biological interest, an interest that should appeal equally to the physiologist, pathologist, and parasitologist. It is a subject on which much work has been done of recent years, and information relating thereto lies scattered in the scientific literature of different countries.

The term symbiosis denotes a condition of conjoint life existing between different organisms that are benefited to a varying degree by the partnership. The condition of life defined as symbiosis may be regarded as balancing between two extremes, complete immunity and deadly infective disease. Symbiosis has doubtless originated from parasitism. One condition merges into the other, there being no line of demarcation to separate them. Some organisms supposed to be symbionts to-day may prove to be parasites on further investigation. Certain structures that have been described in the past as normal intracellular bodies in animals and plants have in a number of cases been shown to be micro-organisms which can be cultivated or symbionts that are transmissible hereditarily from host to host. The address constitutes a summary of what is known to-day of symbiosis in the animal and vegetable kingdoms. Apart from its scientific interest, the economic importance of studies on symbiosis is exemplified by what has been established, on the botanical side, with regard to the root-nodules of leguminous plants, the germination of orchids, and the origin of tubers.

Mental Differences between Individuals.

The address by Dr. Cyril Burt, president of Section J (Psychology), deals with the mental differences between individuals, with special reference to applied psychology in education and industry. The most remarkable advances made by psychology during recent years consist in the rapid development of what threatens to become a new and separate branch of science; namely, the study of individual differences in mind. The numerous data collected from various fields of applied psychology—from the psychology of education, industry, and war, of mental disorder, deficiency, and crime—are now sufficiently extensive and trustworthy to deserve co-ordination into a single systematic body of knowledge.

Early pseudo-scientific attempts to diagnose mental characteristics from physical and other signs were misled by an inadequate technique. The true procedure was supplied by Sir Francis Galton, who applied to the general problem two special methods of inquiry—the statistical method of correlation, and the experimental method of psychological tests. These in turn rest upon a fundamental assumption, which recent work has verified—the continuity of mental variation. This is the keystone of individual psychology as a science. The differences between one man and another are always a matter of "more or less," seldom, if ever, a question of presence or absence or of "all or none." There are no such things as mental types; there are only mental tendencies.

The general scheme under which individuals are to be studied is much the same, whether they are normal or supernormal, backward, defective, or delinquent, or ordinary applicants for vocational guidance.

The positive foundations for a practical psychology of individual differences have been laid in three broad generalisations, each the separate suggestion of recent experimental work. These consist in a trio of important distinctions: the distinction between intellectual and emotional characteristics, between inborn and acquired mental tendencies, and between general and special capacities. The future progress of individual psychology will consist chiefly in devising more exact methods for examining mental qualities under each of these respective heads.

Aspects of the Study of Botany.

Mr. A. G. Tansley's presidential address to Section K (Botany) deals with some aspects of the development of pure botany during the last thirty or forty years, especially in the British Isles. By means of quotations from representative botanists of the last decade of last century, the views held at that time on the relation of morphology and physiology—that they were two independent "disciplines" or branches of botany—are illustrated. It is pointed out that little progress has been made towards realising the idea of determining the "genealogical tree" of the plant kingdom, and this not so much from the fact that our knowledge is still incomplete, as because, in the recent words of a great authority, it has become evident that the past development of the plant kingdom is represented by

"a series of separate lines, some stretching into a remote past, others of more recent origin," and "it would almost seem that 'missing links' have never existed." The increasing doubt as to whether many organs formerly regarded as homologous are really homologous in the strict sense is mentioned, and it is suggested that our increasing, though still rudimentary, knowledge of the factors that determine organic form will lead us to expect a recurrence of the same formative factors, producing similar structures, on different lines of descent, independently of particular life conditions.

The so-called "Neo-Darwinian" account of evolution is then stated, and its weak points indicated; and a description of the changes brought about by the work of Mendel and his followers, of De Vries and of Johannsen, leads to an attempt to form a picture of the origin of species in the light of present knowledge. It is shown that the problems of phylogenesis and ontogenesis are necessarily interlinked, and it is suggested that in the causal study of development of the individual lies the best hope of determining eventually the real nature of the "genes" which geneticists must postulate to account for the observed phenomena of inheritance.

Emphasis is laid on the view that the central and vital part of biology is, and must be, the study of process, and it is suggested that only by stressing this point of view, especially in elementary teaching, will it be possible to retain the power of looking at the science of plants as a whole and thus of checking the disruptive tendencies which have led to the segregation of different branches of the subject.

The Education of the People.

Prof. T. P. Nunn, in his address to Section L (Educational Science), pointed out that the aim of popular education is to train the young to conserve and develop those elements in the tradition of national life and activity which are consciously judged or instinctively felt to be of most worth. Its content will, therefore, always express the distinctive *ethos* of a nation, and, in particular, will reflect the prevalent view as to the proper relation between the individual and the social body. Assuming that in Great Britain we are committed to the ideal of equal citizenship for all, the ultimate aim of our schools must be to bring all children effectively under the influence of those currents in our cultural tradition which have the greatest and most enduring value. Consideration shows that these must include, in addition to our typical traditions of character and manners, the traditions of creative activity represented in literature, science, and the fundamental arts and crafts. The aim thus indicated cannot be achieved so long as education ends for most boys and girls at fourteen; but it does not necessarily imply a "grammar school curriculum" for all. A technical training, provided that it embodies some dignified tradition of intellectual, aesthetic, or practical activity, satisfies the criterion laid down. It is, however, essential that all education should be liberal in outlook and scope.

Science and the Agricultural Crisis.

The main purpose of the presidential address delivered by Dr. Charles Crowther to Section M (Agriculture) is to indicate some of the directions in which immediate help towards the alleviation of the agricultural crisis can be given by the man of science, and some of the lines along which development of our scientific and educational organisation is more especially necessary at this juncture.

The most fundamental of all kinds of assistance that science can give the farmer is that furnished by way of research, but this must of necessity be slow in development, and dependent for the dissemination of its results throughout the industry upon an extensive and efficient advisory organisation in close touch with the farmer.

Similarly also any raising of the standard of farming through formal education can only be effected gradually, and the conclusion is reached, therefore, that the most hopeful way of rendering assistance quickly is through advisory work. The root difficulty of agricultural educational work in the past has been to secure a sufficiently intimate and widespread contact with the farmer, and for this purpose no agency at our command is so valuable as advisory work, involving as it does a contact with the individual farmer which is both direct and sympathetic, originating indeed in most cases out of a direct request for help.

Rapid progress through advisory work postulates, however, a far more numerous staff of advisers than are available at present, some counties being indeed totally unprovided for, while in many others the advisory staff consists of only one man in the person of the County Agricultural Organiser. It is here where the next extension of facilities should take place. In relation to the organisation operating in direct contact with the farmer, research and organised education are for the time being adequately developed—the latter indeed producing now a considerable surplus of trained men for whom employment in educational work is not available. This in itself implies a certain loss of proportion in the development of the whole agricultural educational organisation, and is to be remedied by the extension of the base upon which the whole structure rests, which is constituted of advice, elementary agricultural education, and propaganda. At the same time a closer degree of co-ordination and co-operation between the various elements of the educational organisation is desirable.

In conclusion, although advisory work may be our most effective means of rendering immediate help, a more permanent contribution to the future prosperity of British agriculture will be made through our educational system in the training of the farmers of the future. As yet we have not succeeded in persuading the general body of farmers that technical education is an essential element in the training of the young farmer. The natural development of such a conviction must perhaps be slow, but might be greatly accelerated if more importance were attached to scientific training as well as practical experience in the letting of farms.

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The Ministry of Health.

TRUE versatility is a very wonderful thing, a fit object for the admiration of crowds. History, which is life, offers few examples of true versatility, but what history omits Shakespeare supplies and modern governments assume. Thus the Henry of poetry:

> Never was such a sudden scholar made. . . . Turn him to any cause of policy, The Gordian knot of it he will unloose, Familiar as his garter.

In modern governments, too, abstrusest specialisms must be presumed to grow " like the summer grass, fastest by night." Although Sir William Joynson-Hicks had already held three governmental positions within a year, it may not have been the poetical parallel that has just led to his appointment as Minister of Health; it may have been the old, outworn, Platonic view of the abilities, or absence of them, essential to a statesman; or even mere political exigency. Of one thing we are sure, that the development of a young but vitally important Ministry has been delayed, we hope only temporarily, by the appointment. If a surgeon should ever be offered the woolsack, there is not a lawyer but would deem his previous courses to have been very vain indeed; but to bestow the title of Minister of Health upon a layman evokes singularly little comment. We must be richer than we imagine we are in political genius if the solution of such problems as the inception of an administration of state medicine can be taken up, in a social organisation of such magnitude and complexity as our own, at the rate of four a year. But there is, to the public view, an appearance of difference between the legal and the medical cases, which must be examined and understood before we can proceed intelligently towards an improved condition of affairs.

This aspect of the matter has never been analysed more shrewdly than by Sir Lenthal Cheatle, who, so long ago as last January, set forth to defend the Ministry of Health from the Ministers in the *Nineteenth Century and After*. In his balanced and moderate exposition there is not a loophole left for political control of the office, because the sole reason for political control is objection to medical control, and of such objection nothing survives Sir Lenthal Cheatle's examination. He realises that Dr. Addison's appointment—a purely political appointment, by the way—did not prove, in the opinion of many people, to be a good one. There have been lawyers who have held the Lord Chancellorship and failed in it, lawyers who have held the Premiership and come to grief, lawyers who have held the Irish Secretaryship and brought grief to others; but it is still considered right and proper to appoint a lawyer Solicitor-General, although of Solicitors-General some

have been better than others. Sir Lenthal Cheatle realises that a man can be a good Minister of Health and a bad political tub-thumper, or a great doctor and a bad Minister of Health. He realises that the members of the medical profession actually in the House of Commons, and available for so great a post, are very limited in number, and that occasions may arise when the kind of man wanted would have no seat. Most of the medical members of the present Parliament are there because, first or last, they are politicians, and between them they represent every party opinion in the House. They are not there because politics is the high road to professional advancement. It is not. It is a hobby for medical men who are also men of leisure, the politically minded representatives of politically minded constituencies, who, happily, bring into the deliberations of Parliament, nevertheless, a wealth of special knowledge valuable to the community.

We fail to see in any one of these circumstances an irremediable defect in medical representation or an insuperable barrier to the appointment of a Minister able to direct the first steps of the nation along the pathway to a socially organised health and fitness. But that path is not one of forensic argument. It is one of vision and discovery, possible only to him whose mind is well prepared for the germination of the creative idea by long and close familiarity with the discipline of his science at first hand. Nor must he be sunk beneath the weight of problems of policy and administration foreign to his office, or deprived of jurisdiction essential to its unity. Sir Lenthal Cheatle is right in asserting that the truth, dignity, and force of the public utterances of such an office would themselves advance the cause of health and instruct and benefit mankind. The requisite ability is one that is typically British, exemplified in every department of our Colonial administration, and particularly in the rise of the science of tropical medicine, which is state medicine, under the guidance of British workers.

Possibly it is true that the medical profession itself, having arrived at a clear perception of its functions in modern social life, has not realised how it can make them properly effective. But this opens up questions of great complexity concerning professional and public psychology, both separately and in relation to each other. The pendulum of popular opinion concerning medical men swings from excess to excess through ignorance. In moments of personal thankfulness a doctor is a saint; in moments of collective contemplation he is sometimes worse, but never better than a wordy fool. The people have invented proverbs about doctors, as they have invented proverbs about everything they distrust: proverbs about their differing and about their mistakes. But let a man go to his doctor, or his doctor come to him—a sort of reconciliation occurs. It is a wider thing than it looks, for at heart it is a reconciliation between life and science. The burden of achieving that same reconciliation in politics must fall mainly on the shoulders of the medical profession. Its members we should describe at present as inarticulate rather than dumb, for the medical profession is, after all, a thing of vast subdivisions. Medical science and the profession are not interchangeable terms, and the battle is not the doctors' alone, but theirs for science and the advancement of social life.

Time lived and Time represented.

Durée et simultanéité : à propos de la théorie d'Einstein. Par Henri Bergson. (Bibliothèque de Philosophie contemporaine.) Deuxième édition, augmentée. Pp. x+289. (Paris : Félix Alcan, 1923.) 8 francs net.

WHEN M. Bergson published the original edition of this book last year, he refused to allow its translation because he regarded the work as tentative. It was the result of a special study, which had required a setting aside of purely philosophical research in order to concentrate on mathematical problems. The effect of his intervention in the relativist controversy, which he recognised to be vital in its bearing on the future of mathematics and metaphysics, could not be foreseen. He has now published a second edition, and while he has not found it necessary to revise or alter or modify the first, he has added three appendices, which not only greatly enhance the value, but also enable him in a most striking way to reconcile, and bring into harmony, his theory of time as fundamental reality, l'étoffe même de l'univers (" il n'y a pas d'étoffe plus résistante ni plus substantielle "), with the principle of relativity, according to which time is a variable coefficient, entering with variable spatial coefficients into infinite systems of reference.

The first edition of the book was reviewed in NATURE of October 14, 1922. The review led to a correspondence which is interesting in the fact that it concerned the problem which has called for the new matter in the second edition. This new matter is contained, as we have said, in three appendices, which, though each is complete with its own separate topic, are sequential in the argument and cumulative in force. The first deals with the interesting paradox, " Le voyage en boulet." A very striking mathematical demonstration of it is furnished in a letter addressed to M. Bergson, " par un physicien des plus distingués," which he quotes in full. Two observers, Peter and

Paul, are standing together, and each marks the hour 0^h on his synchronous clock. Paul is then carried suddenly outwards from the earth a specified distance and back again in a rectilinear and uniform movement relatively to the earth and at a velocity of 259,807 kilometres a second. On his return, he finds that Peter's clock records 8^h, while his, Paul's, records 4^h, and it is proved by means of Lorentz's formulæ that each clock has quite correctly measured the time of one and the same event.

Bergson's reply to his correspondent is clear and precise, and involves no dispute as to actual matter of fact. He is able to admit the discrepancy in the time represented and also to affirm the identity of the time lived, and yet to reconcile the paradox. He begins by pointing out that the shortening of the time as measured by Paul's clock is point to point analogous to the contracting of Paul's dimensions as his distance increases in Peter's perspective. Does Peter think, he asks, that because Paul diminishes in his perspective he is really becoming the dwarf he appears? He does not, and he need not, and neither need he suppose that Paul's retarding clock is really registering shorter time. Paul's time, like Paul's dimensions, is the time *represented* by Peter as that which belongs to a system of reference which is not Paul's, but Paul's-system-in-uniform-translation-relatively-to-his-own. It is only Paul's system for Paul when he is immobilised in the system. The paradox arises from supposing that Peter is immobilised in his system of reference, that Paul similarly is immobilised in his, and that the two systems, *while immobilised*, are moving relatively. There is only one time lived, and that is the time of the system in which the observer is immobilised. This may be Peter or it may be Paul, but if it is Peter, Paul's time is *represented* time for Peter, and *vice versa*. Bergson's conclusion is: the formulæ of Lorentz quite simply express what must be the measurements *attributed* to the system S′, if the physicist in system S is to *imagine* that the velocity of light is the same for the physicist in S′ as it is for him in S.

The second appendix deals with the reciprocity of accelerations. Is there perfect equivalence between relative systems of movement when, as in the shock experienced at the sudden stopping of a train, there is a psychical experience which has itself no equivalent? In other words, can there be pure reciprocity in accelerations when certain of the phenomena concern only one of the systems? The argument of this appendix is especially important, and illuminates for the first time a very puzzling position. Stated briefly, it is as follows. If we analyse the acceleration and fix its elements as a succession of represented systems, each in its turn being a system S′ with represented time t' in relation to an immobilised system S with real time t, then the reciprocity is simple and complete; any system which in relation to a system S is a system S′ can itself be a system S, provided that when S′ changes to S, t' becomes t. The symmetry is perfect. But we, on the contrary, are continually representing to ourselves one immobilised system S, to which we oppose a multiplicity of distinct systems animated by various movements, although we still represent them as one unique system S′. When the passenger is thrown from his seat by the sudden stoppage of the train, it is because the material points of his body do not preserve invariable positions in relation to the train. There is no dissymmetry, but instead of a reciprocity between S with t and S′ with t', we have to make the real time belong successively to S″ with t'', S‴ with t''', and so on. The complexity may be infinite, and what we are trying to do is then to make one immobilised system S reciprocal with infinite systems considered not as infinite but as one and unique.

The most important appendix is the third: it deals with real time and world-lines ("Temps propre et ligne d'univers"). It is not possible to abbreviate the argument, which must be read; here we can only indicate its nature. It takes its start from an equation quoted in full from Jean Becquerel. Given a material system of reference, all the points of which are in the same state of movement (*i.e.* any portion of matter in which the spatial distance separating events is null), the time between two events which an observer will measure is the time τ proper to the system, the time which its clocks are registering. A clock in a moving system (whether moving uniformly or non-uniformly) measures the length, divided by the velocity of light, of the arc of the world-line of the system. This principle is worked out to show that in a system in uniform translation (the earth, for example) two clocks to be identical and synchronous must be in the same place. Let one be suddenly and rapidly displaced, and at the end of a certain time (the time of the system) be replaced, it will be found to be retarded. Bergson accepts Becquerel's demonstration (barely indicated here because the mathematical equations are omitted), and proceeds to show how the physicist and the philosopher have each a distinct interest; the physicist must represent a time which is infinitely variable, the philosopher must affirm a time which is absolute and lived. The two interests must be respected and can be reconciled.

Finally, Bergson considers Einstein's case of a field of gravitation produced by the rotation of a disk. In such a system, he quotes Einstein as saying, "It is impossible to determine time by means of clocks which are immobile as regards the system." But is

it true, asks Bergson, that the disk constitutes *one* system? It is only a system if we suppose it immobile; but in that case we are placing a real physicist on it, and then on whatever point of the disk we immobilise this real physicist with his real clock, we have the time which is one and lived. In short, we have to choose. Either the disk is thought of as rotating, and then gravitation is resolved into inertia. This is how the physicist *represents* it, and not as it is for him living and conscious; but then the times measured by the retarded clocks are represented times, and of these there is infinity; the disk will be a multiplicity of systems. Or else this same rotating disk is thought of as immobile. Then inertia at once becomes gravitation. The real physicist now lives its time, and so considered time is one and the same everywhere.

The importance of the book from the point of view of philosophy can scarcely be exaggerated. It accepts frankly the paradox of relativity, goes behind it, and exposes it. The retarding of clocks in systems accelerated relatively to the observer's immobilised system is shown to be a case in point of the relativity of magnitudes. Just as the real dimensions of an object are its spatial magnitudes for an observer immobilised at that point of the universe at which the object is, so the time τ belonging to any system is the time lived by an observer immobilised in that system. For every immobilised observer the times and spaces of other systems are infinitely variable, but these variations are perspectives, represented not lived.

H. WILDON CARR.

Projective Geometry.

(1) *Principles of Geometry.* By Prof. H. F. Baker. Vol. 2: Plane Geometry, Conics, Circles, Non-Euclidean Geometry. Pp. xv+243. (Cambridge: At the University Press, 1922.) 15*s.* net.

(2) *Higher Geometry: An Introduction to Advanced Methods in Analytic Geometry.* By Prof. F. S. Woods. Pp. x+423. (Boston and London: Ginn and Co., 1922.) 22*s.* 6*d.* net.

(3) *Elements of Projective Geometry.* By G. H. Ling, G. Wentworth, and D. E. Smith. (Wentworth-Smith Mathematical Series.) Pp. vi+186. (Boston and London: Ginn and Co., 1922.) 12*s.* 6*d.* net.

(1) CHRISTIAN VON STAUDT'S "Beiträge zur Geometrie der Lage" was published so long ago as 1857; about the year 1871 Felix Klein wrote a series of papers emphasising the fact that it is possible to build up, on von Staudt's lines, the whole of projective geometry, independently not only of axioms of parallelism but also of the notions of distance and congruence. Yet it is astonishing how little effect this discovery has had upon English treatises on projective geometry, which still, with very few exceptions, base their subject upon metrical geometry, and are content to prove purely projective properties of conics by "projecting into a circle." There are, it is true, Whitehead's two tracts on the "Axioms of Projective Geometry" and "Axioms of Descriptive Geometry," but these, as their titles imply, deal only with the logical preliminaries. There is also G. B. Mathews' "Projective Geometry," which suffers rather from undue compression and somewhat confuses the issue by talking about infinity so early as Chapter II.; and there is the important two-volume treatise by Veblen and Young, which is certainly not for the ordinary man.

There was obviously room for a lucid and logical account of the whole of the more elementary parts of geometry, conics, and quadrics and cubic surfaces, developed from the projective point of view, and that is what Prof. Baker's series on the "Principles of Geometry," of which this is the second volume, aims at supplying. Its publication, then, is an event of the greatest importance. Prof. Baker believes that much time "could be saved by following, from the beginning, after an extensive study of diagrams and models, the order of development adopted in this book; and such a plan would make much less demand upon the memory" than does the traditional treatment. Is it not about time that some such course were adopted for University students of scholarship standard in their first year? The ideas involved are, perhaps, difficult, but not more so than those which the Cambridge freshman is expected to assimilate from lectures on analysis.

In the first chapter a conic is defined in the usual way as the locus of the intersection of corresponding rays of two related pencils of lines in the same plane; next, Pascal's theorem and the theory of polarity are developed; and then there are forty most interesting pages of examples of the application of the foregoing theorems in various directions. The theory of outpolar conics, Poncelet's theorem and Hamilton's extension of Feuerbach's theorem may be mentioned. Chapter II. summarises properties of conics relative to two points of reference, and gives a number of results containing those usually developed as consequences of the notion of distance. The terms current in metrical geometry, *perpendicular*, *circle*, *rectangular hyperbola*, and so on, are used for the sake of clearness, but have here, of course, a much more general meaning, depending upon the choice of the absolute points of reference.

In the first volume of the series an algebraic

symbolism was introduced to accompany the geometrical reasoning; in the third chapter of the present volume this symbolism is applied to the matters in hand. The symbols employed consist of the iterative symbols, and those derived from them as the irrational numbers of arithmetic are derived from the rational numbers, together with combinations of such symbols of the form $x+iy$, i denoting a new symbol such that $i^2=-1$. In Chapter IV. it is shown that if we introduce certain laws of order of succession, the symbols are, in manipulation, indistinguishable from the complex numbers of ordinary analysis. The distinction between real and imaginary elements is then discussed. The last chapter deals with the notion of the interval of two points of a line, and the angular interval of two lines through a point, defined projectively in regard to an absolute conic, and leads up to a discussion of non-Euclidean geometry. There follow two important appendices dealing with certain configurations of points and lines, and, in particular, with the complete figure of Pascal's theorem, which is best considered from four dimensions.

Much of the matter contained in this work is, of course, familiar enough, though often presented from a new point of view; in places, especially in Chapter III., extreme condensation of treatment makes difficult reading, but one can browse with pleasure and profit from almost anywhere in its pages, and surely that is a test of a good book. The printing and diagrams are excellent, as one would expect from the Cambridge University Press; we would like to single out for special mention the frontispiece, the Hexagrammum Mysticum, which any one who has tried to draw the figure will recognise as simply marvellous.

(2) Going on from Prof. Baker's book to Prof. Woods', one feels a little confused. Prof. Woods is concerned with "advanced work in algebraic geometry" and so does not worry about the foundations, but it is rather difficult to determine what his foundations are. One's first impression is that he defines a point (in a plane) by means of three numbers, real or complex, and then the line joining two points x_i, y_i as the set of points $x_i+\lambda y_i$ ($i=1, 2, 3$), which is quite logical, though in Prof. Baker's opinion it "appears to beg one of the main, and most interesting, questions arising in the foundations of geometry," but then, on p. 28, Prof. Woods refers for the proof of the theorem that any linear equation represents a straight line "to any text-book on analytic geometry." This criticism may appear pedantic, but the underlying idea of the book is, very properly, the group concept, and the logical attitude is, surely, to begin with the projective group and afterwards to consider its sub-groups, the metrical group, and so on. Also discussions of non-Euclidean geometry (Chapter VII.) seem a little unsatisfactory if the idea of distance has been present from the beginning.

Prof. Woods' book, however, contains a very great deal of interesting and valuable matter not elsewhere accessible in any one volume. His plan is to study different co-ordinate systems, based upon various geometric elements and classified according to the number of dimensions involved. Thus in three-dimensional geometry he considers first the circles of a plane and then point and plane co-ordinates; in four-dimensional geometry the lines of three-dimensional space, spheres and four-dimensional point space, in each case studying the meaning of the linear and quadratic equations. Contact transformations, tetracyclical and pentaspherical co-ordinates are also dealt with. There are numerous exercises. The author is to be congratulated on his determination to "preserve the English idiom" by not using such a phrase as "a line *on* a point," although this has considerable authority behind it now and was introduced, we believe, by an Englishman. The word "nonminimum" would have looked better, surely, with a hyphen; the extra expense involved in printing could have been saved by omitting the diæresis in the much more frequently occurring word "coördinate."

(3) There is little to say about the third work under review. It is a clearly set out, elementary school-book on projective geometry on the ordinary lines, built up upon a metric foundation and excluding any consideration of imaginary elements. A desire to be simple has led to some doubtful statements, *e.g.* "the greatest number of points of a figure that lie on a line which is not entirely in the figure is called the *order of the figure*." But the book may be recommended as a good example of its class; and there is an attractive Greek alphabet on p. vi. The historical note at the end is not so good as one would have expected in a book with which Prof. D. E. Smith is associated.

F. P. W.

The Distribution of Mental Products.

A Short History of the International Language Movement. By Albert Léon Guérard. Pp. 268. (London: T. Fisher Unwin, Ltd., 1922.) 21*s.* net.

PROBABLY no subject is more distasteful to the average educated Englishman than the question of an "artificial auxiliary language." If he be a literary scholar, he feels insulted; if a man of business and affairs, he is coldly indifferent and incredulous. A few men of science may, perhaps, be mildly curious and politely tolerant. If anything can awaken interest and overcome prejudice, it will be this book written

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by Prof. Guérard, if only by reason of its literary quality and attractive style. But the volume possesses many other merits, since it is by far the best work that has been written on this particular subject. Indeed nothing to compare with it has appeared since the learned and rather ponderous "Histories" of Profs. Couturat and Leau. Moreover, Prof. Guérard takes a wide and dispassionate sweep, considering the respective merits and possibilities of French, English, and Latin, as well as those of the "artificial" languages. Very full information is given with regard to the history and structure of all the more important projects, including, besides the so-called "philosophical" languages, Volapük, Esperanto, Ido, Interlingua, Latino sine Flexione, Idiom Neutral, Panroman, Romanal, etc.

There are three appendices, giving, respectively, a bibliography of the subject, a fairly complete list of all known auxiliary language schemes, and a critical comparison of Esperanto, Ido, Interlingua, and Romanal. There is also an index. Throughout the whole book the author displays a cool and critical judgment, combined with much wit and an incisive literary style. The result makes very interesting reading. He is a firm believer in the possibility (and actuality) of an artificial *auxiliary* language for general human intercourse, and drives his point home by cool reasoning devoid of any vestige of emotional fanaticism. His personal predilections are kept well in the background, though he gives good reasons for preferring a language with an Anglo-Latin etymological basis. Like Dr. Cottrell, however, he is in favour of "getting ahead." Several of the existing systems are, in his opinion, good enough for present work-a-day purposes.

An auxiliary international language is a simple transmitting mechanism for the "distribution and exchange" of ideas and information. It is not a romantic revival or a philological trap for the unwary; but just something of great value and usefulness for hundreds of millions of plain folk, who have not time to acquire real facility in five or six national languages. It is not intended to, and will not and cannot, replace or injure national languages. It comes as no destroyer of the family or national hearth; nor is it the siren music of a denationalised intellectualism, or the fierce breathings of an anti-national proletariat. So the plain decent Englishman need have no fear, though he is often a pretty sincere hater of internationalism. The very word is apt to suggest to him the roaring of some hairy and hydra-headed monster ready to defile the fair green fields of England. Sometimes the prejudice takes another form. The present writer once asked a very distinguished Englishman what he thought about the question of an auxiliary international language. The answer was that he had studied Esperanto, but had given it up because the people who spoke it were not the people he wanted to speak to. The onward march of events will sweep away all such fears and prejudices. Even very distinguished Englishmen use aeroplanes and wireless sets, and are to be found in cinema theatres, and dancing to the strains of a gramophone.

Auxiliary language is not an easy *descensus Averni* or a difficult ascent *per ardua ad astra*. It is not for devil or saint, but for the smooth middle way of life. Nor is it something that exists only in the minds of cranks and idealists, for it is with us here and now, is already much used and advancing rapidly. It is not to be expected that old gentlemen in Club arm-chairs will trouble much about it. The important thing is that teachers might test and develop the idea in the schools. Here in the great workshops of early human development there exists a wonderful field for practical work and for very interesting linguistic and psychological researches. There is, indeed, a veritable gold mine here awaiting those who have the insight and energy to discover and develop it. The phoneticians can render valuable aid with their modern analysis and standardisation of the sounds of human speech, while mathematicians and philosophers need not despise a subject that has deeply interested Descartes, Leibniz, Couturat, and Peano.

F. G. D.

Mining and Mineral Deposits.

(1) *Manuel du Prospecteur*. Par P. Bresson. (Bibliothèque professionnelle.) Pp. 452. (Paris: J.-B. Baillière et fils, 1923.) 12 francs net.

(2) *Imperial Institute: Monographs on Mineral Resources with Special Reference to the British Empire. Copper Ores*. By R. Allen. Pp. x+221. (London: John Murray, 1923.) 7*s*. 6*d*. net.

(3) *Imperial Institute: Monographs on Mineral Resources with Special Reference to the British Empire. Mercury Ores*. By E. Halse. Pp. ix+101. (London: John Murray, 1923.) 5*s*. net.

(4) *Nickel: the Mining, Refining and Applications of Nickel*. By F. B. Howard White. (Pitman's Common Commodities and Industries.) Pp. x+118. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 3*s*. net.

(5) *Report on the Cupriferous Deposits of Cyprus*. By Prof. C. Gilbert Cullis and A. Broughton Edge. Pp. 48+5 plates. (London: The Crown Agents for the Colonies, 1922.) 20*s*.

(1) A BRIEF glance at the contents of this manual suffices to arouse grave doubts as to the author's knowledge of real prospectors. No one who

has sat by a prospector's camp fire or shared his hardships in the field, who knows the type of tough, hardy fellow who starts out to prospect an unknown country with the customary simple equipment—often nothing more than pick, shovel and pan, a bag of food, and a gun across his shoulder—could imagine that chemical equations and crystallographic systems could be of the remotest use or of the faintest interest to him in any circumstances whatever. It is quite certain that he would grudge even the small space that this book would occupy in his pack, even supposing that he could understand it.

If the author, on the other hand, had in mind the preparation of a work suitable for the trained mining geologist, such a man as might be selected as the leader of an important exploring expedition, then it can only be said that the scientific section of the book is too rudimentary and inaccurate to be of use to him. To give one example: a thorough knowledge of mineral deposits is above everything else the first essential for a mining geologist; our author informs us that M. De Launay's "Traité des gîtes métallifères" "contains everything that is known" of the science of ore deposits. There is, however, no such book as he names; he must mean either M. De Launay's "Formation des gîtes métallifères," or else the "Traité des gîtes minéraux et métallifères" by Fuchs and De Launay, both of which were published in 1893. Few branches of scientific study have made more progress than has this one in the last quarter of a century, and the statement that a book written thirty years ago presents the sum of our knowledge of the subject to-day is altogether misleading.

As regards the rest of the book, it may be said that only a small portion is devoted to matter that could interest a prospector of any type; nearly one-half of it is taken up with a sketch of mining operations with which the prospector has nothing whatever to do. Thus it would probably be of use to him to have a correct drawing and description showing how to construct a windlass, but this is barely mentioned, whereas many pages are devoted to the headgears and winding machinery suitable to a large working mine. In the same way, ventilating fans, rock drills, dressing plant and other appliances necessary for a mine in full operation are described in what is entitled a prospector's manual. We wonder if M. Bresson thinks that a prospector really uses any of these.

(2), (3) These two volumes constitute additions to the series of monographs on mineral resources issued by the Imperial Institute, and follow closely the general scheme adopted in previous examples. There is an opening chapter describing briefly the more important ores of the particular metal under discussion, their mode of occurrence, and the general principles of the metallurgical processes employed for the production of the metal. The general uses to which it is put, its prices over a period of years, and statistics of production and trade movements complete this part. The second chapter describes the chief occurrences of the ores within the British Empire, and a third chapter is devoted to deposits in foreign countries; finally a set of references to the literature of the particular subject concludes each volume.

Of these two books it need only be said that the work has been painstakingly and carefully performed, and that they constitute useful handbooks for those requiring general information upon the sources of supply of the two metals in question. The compilation of the volume on copper ores was no doubt the easier task of the two, because much has been written on the subject of copper, notably the volume on copper issued in 1922 by the Imperial Mineral Resources Bureau, which had, indeed, rendered Mr. Allen's work practically superfluous, seeing that the earlier book has covered the same ground as the present volume. Perhaps Mr. Allen himself felt this, because it is noteworthy that he omits this particular work from the list of references quoted by him. He has also missed a number of important monographs issued by the United States Geological Survey, which are, moreover, cited in the much more complete bibliography attached to the work of the Imperial Mineral Resources Bureau.

Mr. Halse had far less assistance in his task; the Imperial Mineral Resources Bureau had indeed issued a volume on quicksilver in 1922, and this again is not referred to in the bibliography attached to Mr. Halse's volume. We trust that the omissions in each case are accidental and not intentional. The bulletin of the Imperial Mineral Resources Bureau contains far less technical information upon the mode of occurrence of mercury deposits, and Mr. Halse has done this part of his work extremely well. Of course it so happens that no mercury, practically speaking, is produced within the British Empire, so that the Imperial Mineral Resources Bureau was bound to treat the subject in a somewhat summary fashion, thus making Mr. Halse's work decidedly more necessary for those who desire a general knowledge of the mode of occurrence of mercury ores.

(4) Mr. Howard White's work constitutes a popular handbook giving in a compact form the main facts concerning the occurrence, preparation, refining and applications of nickel. It is probably quite true, as the author states in his preface, that "comparatively little is known about nickel by the general public," but it should in all fairness be added that no one desiring such information can have the least difficulty in obtaining it since the publication in 1917 of the elaborate report of

the Royal Ontario Nickel Commission, with which the name of its chairman, Mr. G. T. Holloway, will always be associated. The little book before us is very well written; within the space of little more than a hundred pages it deals clearly and comprehensively with this subject and should prove extremely useful to the non-technical reader, who wants trustworthy general information concerning a metal, the industrial applications of which have been increasing steadily during recent years. To any one desiring such information the book can be heartily recommended.

(5) This work is necessarily entirely different from those already considered; it is a scientific report, addressed to the Colonial Secretary, upon the known copper deposits in the Island of Cyprus and the possibility of discovering others of economic importance. Apart from the economic aspect of the work, it possesses a high degree of historical and antiquarian interest, for it is generally held that the main supplies of copper in early historic times were derived from this island, which is indeed said to have given its name to the metal. The deposits of copper ore now known are, however, of relatively low grade, consisting in fact of cupriferous pyrites rather than of true copper ores, but this fact is not incompatible with the previous existence, at the outcrops of such deposits, of gozzans rich in oxidised ores, with possibly a zone of secondarily enriched sulphide ores immediately below them. Such ores could have been successfully treated in those ancient times, although it may be doubted whether metallurgical skill was equal to the task of extracting the copper from a low grade cupriferous pyrites. Nor would it be at all extraordinary that an industry carried on for some thousands of years should have worked up every trace of available mineral.

The report indicates that there is only one mine of economic importance known up-to-date in the Island of Cyprus, namely, the Skouriotissa mine, worked by an American company, the Cyprus Mines Corporation. The mineral deposit consists of a large mass of cupriferous pyrites, estimated to contain some six million tons of ore assaying apparently between 49 and 50 per cent. of sulphur and between 1·8 and 2·5 per cent. of copper. An English company, the Cyprus Sulphur and Copper Company, holds a concession on the Lymni mine, estimated to contain 2¼ million tons of ore in the form of disseminated cupriferous pyrites, with 19·5 per cent. of sulphur and 1·25 per cent. of copper, which is thus too poor to be capable of profitable exploitation at the moment. A number of prospecting permits have been granted, and the authors of the report state the grounds upon which they consider it quite possible that other payable ore bodies may yet be discovered. The authors may fairly be congratulated upon the publication of an excellent piece of work, which will interest equally the mining geologist and the archaeologist.

HENRY LOUIS.

Our Bookshelf.

Liverpool Marine Biology Committee. L.M.B.C. Memoirs on Typical British Marine Plants and Animals. XXV: Asterias. By Herbert C. Chadwick. Pp. viii + 63, 9 plates. (Liverpool: University of Liverpool Press, Ltd.; London: Hodder and Stoughton, Ltd., 1923.) 4*s*. 6*d*. net.

To this useful series of descriptions of common marine animals and plants Mr. Chadwick has previously contributed excellent accounts of Echinus, Antedon, and Echinoderm Larvæ. This description of our common starfish (*Asterias rubens*), with its nine carefully drawn and clearly reproduced plates, even betters his previous performance.

While taking advantage of the large amount of previous work on this well-known echinoderm, notably the embryological observations of Profs. MacBride and Gemmill, Mr. Chadwick appears to have verified nearly all his statements by his own dissection and observation, and when he has not done so he is careful to say as much, as well as to indicate one or two points in which he has been led to differ from the majority. Thus, he does not believe that a single ray can regenerate the whole animal; Helen Dean King, he might have noted, proved twenty-five years ago that to effect this the ray must retain approximately one-fifth of the disc.

On the vexed question of the axial organ and axial sinus Mr. Chadwick "is inclined to support Gemmill's conclusions that in Asterids this system is really hæmal, etc." This may be true physiologically and in part, though some of the evidence, as he admits, is not conclusive; but it does not rule out the morphological interpretation of the organ as a genital stolon, a view, by the way, which is far from having originated with MacBride, as Mr. Chadwick implies. Among the divergent accounts of the minute histology of the eye-spot, that of Cuénot is most in accord with Mr. Chadwick's own observations, but differs from them in denying any lenticular thickening of the cuticle. Though in his diagrams he draws and denotes the apical nervous system, "the writer has been unable to find any trace of this system in any of the large number of serial sections examined by him."

One or two points of terminology are open to question. If, as is generally admitted, the terminals are homologous with the [first] radials of Crinoidea, it is puzzling to call the plates which lie proximally to them the first, second, etc., radials; they correspond to the superbasals of Acrocrinus. The rays are numbered according to the method of MacBride and Gemmill. The method which I based on the primary water-pore as a fixed point, and which Sedgwick adopted as conducing to clearness and precision, is, in Mr. Chadwick's opinion, "worthy of the fullest consideration," but he does not seem to have given full consideration to the criticism of the Gemmill-MacBride system published in my "Studies on Edrioasteroidea." In any

case it is surely confusing to apply the term "anterior" to the anal interradius. Such differences of opinion cannot, however, detract from the value of a book which is essentially a clear and accurate statement of things seen. F. A. Bather.

Les Zoocécidies des plantes d'Afrique, d'Asie, et d'Océanie. Par Prof. C. Houard. Tome 1: Cryptogames, Gymnospermes, Monocotylédones, Dicotylédones (1re partie), Nos. 1 à 1806. Pp. 496. Tome 2: Dicotylédones (2e partie), Index bibliographique, Nos. 1807 à 3293. Pp. 497–1056. (Paris: J. Hermann, 1922–1923.) 2 vols. 100 francs.

During the years 1906–1913, Prof. Houard, professor of botany in the University of Strasbourg, placed all cecidologists deeply in his debt by the issue of his three fine volumes on "Les Zoocécidies des plantes d'Europe et du bassin de la Méditerranée." He has now covered Africa, Asia, and Australasia. Only America remains, and it is to be hoped that Prof. Houard will continue his indefatigable labours and encompass the zoocecidology of the globe. The present work is based essentially on the same plan as its predecessor: a short introduction and table of abbreviations, and then a descriptive catalogue of the animal galls of plants, the latter arranged systematically according to Engler and Prantl's "Pflanzenfamilien." This is followed by a bibliographical index of more than seven hundred memoirs of which Prof. Houard himself may be justly proud to claim sixty-five items; by zoological and alphabetical tables of the animal organisms producing galls on plants, an index of plant hosts, and a general index. The volumes are illustrated by a portrait frontispiece and nearly two thousand figures, which although small are quite adequate.

Three thousand two hundred and ninety-three galls are described, and by his ingenious system of abbreviations, and rather rare power of indicating the chief morphological features in a few words, Prof. Houard manages to convey, often in a line or two of print, quite an astonishing amount of information concerning the structure of the gall, its geographical distribution and the causal agent. To each description is appended the bibliography of the particular gall with a note of the memoirs in which a figure is to be found.

Looking through the bibliography one is a little dismayed to find how little British cecidologists have contributed toward a knowledge of the galls found in lands within the British Empire. There are, of course, exceptions, as the well-known names of Lounsbury, Froggatt, Fuller, Green, Maskell, and others indicate, but one must confess that one would like to see British names a little more prominent and numerous. The volumes are very well produced, and botanist and zoologist alike will thank Prof. Houard for placing in their hands so valuable a contribution to so fascinating a subject.

La Radiologie et la guerre. By Mme. P. Curie. (Nouvelle Collection scientifique.) Pp. 144 + xvi Plates. (Paris: Félix Alcan, 1921.) 8 francs net.

The distinguished author of this little book narrates briefly the part which the X-rays played in the medical services of the French Army during the War, or more correctly the radiological experiences which she herself had during those momentous years as technical director of the radiological work of the Patronage National des Blessés.

The book commences with two short chapters on the nature and production of X-rays. Then follows an account of typical installations employed in hospitals and lorries in the field. A chapter is given up to a description of radiological work in hospitals and is devoted mainly to methods of localising foreign bodies and the examination of fractures. Mme. Curie expresses herself in favour of a preliminary fluorescent screen examination before resorting to photography—a subject on which there is a division of opinion in Great Britain. There is a paragraph on the protective measures essential for the X-ray operator. It is now well known that complete protection may be secured; and in Great Britain at any rate, there has latterly been a steady improvement in the working conditions in hospitals and elsewhere, thanks to the work of the X-ray and Radium Protection Committee and the National Physical Laboratory.

Later chapters in the book deal with questions of personnel and organisation of X-ray departments. Brief mention is made of radiotherapy and radium therapy. As was the case with the British army, when the value of the X-rays had been realised there was an enormous expansion of the French radiological services during the War; and Mme. Curie quotes some striking figures in this connexion. For example, she estimates that in the course of the years 1917 and 1918, well over one million X-ray examinations were conducted by the organisation under her direction.

The nation's appreciation of war achievements is now dulled, but this little book prompts the suggestion that an account of the British radiological activities during the War should be put on record.

G. W. C. K.

Light and Colour. By Dr. R. A. Houstoun. Pp. xi + 179 + 10 plates. (London: Longmans, Green and Co., 1923.) 7*s.* 6*d.* net.

Dr. Houstoun's book deals with wide aspects of the science of light and colour, and will be found of interest by photographers and medical students as well as by members of the public generally. There is an excellent chapter on invisible rays, including a description of Prof. Rankine's method of wireless telephony and Dr. Fournier's optophone, by which a blind man is able to read ordinary printed matter, such as books and newspapers. A very clear and simple account of the X-ray spectrometer is included, and also an account of the current views of the structure of the atom. Primary and complementary colours are described by the author, who gives the usual table of complementary colours—that of Helmholtz—while he states that Helmholtz is not so definite on the subject as is generally supposed: he does not give the defects of Helmholtz's methods, by which indeed no consistent results can be obtained. In ascertaining complementary colours it is absolutely necessary that a comparison white light of known composition be used. Without this there is only a mental estimation of the white, in other words guesswork.

Colour blindness and various methods of detecting

the colour blind are described. In this chapter, as in others, the author shows his appreciation of the physiological aspects of the subject. The section on photochemistry deals with the photographic process, the bleaching of the visual purple, the spectral sensibility curve of *Volvox globator*, and the photo-sensory process of the clam, *Mya Arenaria*. The two concluding chapters deal with phototherapy and dangerous light sources, such as the quartz mercury arc, iron and tungsten arcs, which emit ultra-violet radiations of wave-lengths shorter than 2930 Å.U., and cause a painful inflammation of the eyes and skin. The last chapter deals with the psychology of colour. The book is very well illustrated. F. W. EDRIDGE-GREEN.

Die Fernrohre und Entfernungsmesser. Von Dr. A. König (Naturwissenschaftliche Monographien und Lehrbücher, Band 5). Pp. vii + 207. (Berlin: J. Springer, 1923.) 7*s.* 6*d.*

THIS book expresses the views of one whose academic knowledge is supplemented by considerable practical experience; it contains, therefore, much information that a designer of optical instruments will appreciate. There are three sections dealing comprehensively with the various types and details of telescopes, micrometers, and rangefinders.

The author has unconsciously rather impaired the agreeable impression of impartiality created by the text through the association of the name of his firm with so many of the instruments illustrated. For example, it might be concluded that the well-known design of dial sight which reflects so much credit upon another German firm was attributable to Messrs. Carl Zeiss.

Many of the illustrations have been reproduced from other works and are already well known, and the author has not completely solved the very difficult problem of representing without confusion the paths of rays through prisms of complex form. He describes the theoretical Ramsden eyepiece which has the field lens in the focal plane, but illustrates the practical Ramsden having the field lens f/4 beyond the focus. Too favourable an impression of the practical clearness of optical glass is created by indicating the absorption for $\lambda = 0{\cdot}48\ \mu$. The date and place of Kepler's death as given do not agree with those inscribed upon his tomb, and stereoscopic rangefinders are advocated for reasons that are no longer accepted by responsible German naval officers.

Notwithstanding these and other minor criticisms that might be expressed, Dr. König's book is an excellent one that should prove most useful to all directly or indirectly interested in the science of optical instruments. JAMES WEIR FRENCH.

Die europäischen Bienen (Apidæ). Bearbeitet von Prof. Dr. H. Friese. Lieferung 2. Pp. 113-208 + Tafeln 8-13. 10*s.* Lieferung 3. Pp. 209-304 + Tafeln 14-19. 5*s.* Lieferung 4. Pp. 305-400 + Tafeln 20-25. 5*s.* (Berlin und Leipzig: W. de Gruyter und Co., 1922–1923.)

THE first part of this work has already been noticed in our columns. Parts II. to IV., which have recently come to hand, are devoted to an account of the behaviour, nesting habits, distribution, parasites, etc., of typical members of the various genera of European bees. The classification adopted is essentially biological, bees being treated as solitary, social, and parasitic as the case may be. Perhaps the best feature in the book is the descriptions of the nesting habits, which are accompanied by numerous figures, and practically all the plates are devoted to various phases of this subject. The majority of the illustrations are original and of a high standard of excellence, and many of the plates are exceedingly attractive. The value of others is somewhat marred by the addition of too much extraneous scenery in the shape of hills, roads, etc., as well as buildings. The author's object no doubt is to portray the surroundings in which the species live. The genera Osmia, Halictus, and Chalcidoma are particularly well treated. Chalcidoma occupies no less than six of the plates, but the great genus Andrena scarcely seems to come in for its adequate share of illustration. We look forward to the appearance of the final instalment of the work, and can cordially recommend the parts already issued as a trustworthy and very readable presentation of the habits and economy of the insects of which it treats.

Elements of Natural Science. By W. Bernard Smith. Part 2. Pp. viii + 268. (London: E. Arnold and Co., 1923.) 5*s.* 6*d.*

PUBLIC School science masters have not yet arrived at complete agreement as to how and what science should be taught in general education. The majority of their pupils are not destined for careers and professions in which a definite training in any one branch of science is essential; yet all, in this age which has realised that science is power, should be taught something of the scientific method, and should gain at least an introduction to each of the subjects on which personal and national welfare depend. Mr. Bernard Smith has here made an interesting attempt to steer a safe course between the Scylla of specialist teaching and the Charybdis of smattering, but in places sails perilously near the whirlpool. This Part II. is concerned with electricity and magnetism, astronomy, geology, biology, physiology, and hygiene, and the principles of agriculture. Of these the first three are handled rather more successfully than the others; but throughout the needs of an ordinarily intelligent and well-educated "man in the street" have been kept in mind.

Chemistry, Inorganic and Organic: With Experiments. By C. L. Bloxam. Eleventh edition, revised by A. G. Bloxam and Dr. S. Judd Lewis. Pp. x + 832. (London: J. and A. Churchill, 1923.) 36*s.* net.

THE first edition of Bloxam's textbook was published in 1867. It must evidently have undergone very extensive revision. There can be scarcely a page of the original book left. The revision in the present edition has been wisely and thoroughly done, and the book is one which will be found most useful for reference purposes in schools or institutions where large treatises are not available. It covers the whole of chemistry in an interesting manner, and the descriptions of experiments are especially noteworthy. Many of these were new to the reviewer. The book will probably be found most useful to medical and pharmaceutical students for reference purposes, although it has a wider appeal.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Recoil of Electrons from Scattered X-Rays.

IN a recent paper before the Royal Society (as reported in NATURE, July 7, p. 26), C. T. R. Wilson announced that in his cloud expansion pictures of secondary β-rays produced by X-rays shorter than 0·5 Å, tracks of very short range appear. These electrons, he says, "are ejected nearly along the direction of the primary X-rays."

A quantum theory of the scattering of X-rays, devised primarily to account for the change in wave-length which occurs when X-rays are scattered, led me to predict (Bulletin National Research Council, No. 20, pp. 19 and 27, October 1922) that electrons should be ejected from atoms whenever X-rays are scattered. The idea is that a quantum of radiation is scattered in a definite direction by an individual electron. The change in momentum of the radiation, due to its change in direction, results in a recoil of the electron which deflects the ray. The direction of recoil is not far from that of the primary beam, in accord with Wilson's observation on his short tracks.

Corresponding to this momentum acquired by the electron, it has kinetic energy which varies from 0 when the scattered X-ray proceeds forward, to a maximum value $h\nu . 2\alpha/(1+2\alpha)$, when the ray is scattered backward (P. Debye, *Phys. Zeitschr.* 24, 161, Apr. 15, 1923; A. H. Compton, *Phys. Rev.* 21, 486, May 1923). Here $\alpha = \gamma/\lambda$, where $\gamma = h/mc = 0{\cdot}0242$ Å, and λ is the incident wave-length. The ratio of the maximum energy of a photoelectron excited by an X-ray to the maximum energy of such a recoil electron would thus be $(1+2\alpha)/2\alpha$. But Wilson finds the length of the trails proportional to the square of the energy. The track due to the photoelectron should therefore be $(1+2\alpha)^2/4\alpha^2$ times that of the longest recoil electron tracks.

Taking Wilson's datum that a track of 1 cm. corresponds to 21,000 volts, the equation $Ve = hc/\lambda$ indicates that a ray of wave-length 0·5 Å will eject a photoelectron with a path of 1·4 cm. The recoil electron, taking $\alpha = 0{\cdot}0242/0{\cdot}5$, should accordingly have a range of 0·11 mm., which should just be visible. For his harder X-rays, with a wave-length for example of 0·242 Å ($\alpha = 0{\cdot}1$), the recoil tracks on Wilson's photographs should be as long as 1·7 mm. The quantum idea of X-ray scattering thus leads to recoil electrons moving in the right direction and possessing energy which is of the same order of magnitude as that possessed by the electrons responsible for C. T. R. Wilson's very short tracks.

ARTHUR H. COMPTON.
University of Chicago,
August 4.

As Prof. Compton points out, the phenomena relating to the forward directed β-ray tracks of short range, which appear in air exposed to X-rays of short wave-length, are in agreement with his suggestion that scattering of a quantum may be effected by a single electron.

That the phenomena are in general accordance with Compton's theory was pointed out in my paper (which has now appeared in the current number of the Proc. Roy. Soc.); mention of this was made in my summary of the paper, but was omitted in the abbreviated report of that summary which appeared in NATURE of July 7.

It is obvious that further observations on the range and direction of tracks of this type produced by homogeneous radiations may throw light on some very fundamental questions. The data thus far obtained by this method are not sufficient to decide without ambiguity whether a quantum of radiation scattered by an electron is emitted in one direction only or with a continuous wave-front.

C. T. R. WILSON.
Cambridge, August 24.

Long-range Particles from Radium-active Deposit.

WITH reference to the communication of G. Kirsch and H. Pettersson in the issue of NATURE of September 15, p. 394, on the "Sources of long-range H-particles," the results of an examination by the scintillation method of the particles emitted by radium-active deposit, in which we have been engaged for the past six months, are of interest.

It was found that the active deposit, radium B + C, on a brass disc emitted particles with ranges (in air at 15° C. and a pressure of 760 mm. of mercury) of 9·3, 11·1, and 13·2 cm. respectively, as well as particles of which the range was considerably greater than 18 cm., which were not further investigated, as they appeared to be H-particles. The particles of range 9·3 cm. were previously observed by Sir Ernest Rutherford (*Phil. Mag.*, xxxvii., 1919, p. 571).

Although it would not be possible definitely to decide that these particles were α-rays except by their deflexions in electric and magnetic fields, the appearance of the scintillations strongly suggests that they are α-rays. The numbers of these additional particles were relatively very small; for every 10^7 α-rays of range 6·97 cm. emitted by the source, there were present 380, 126, and 65 particles of ranges 9·3, 11·1, and 13·2 cm. respectively, together with about 160 long-range H-particles.

To ensure that these long-range particles were not produced by collisions by the 6·97 cm. α-particles with air molecules, the experiments on the 11·1 and 13·2 cm. particles were repeated, using carbon dioxide in place of air. In this case the equivalent ranges in air were found to be 11·3 and 13·6 cm. respectively, the agreement being considered satisfactory, as the measurements in carbon dioxide were not made with the same precision as in air.

Moreover, these particles could not have been excited in the mica sheets which were used to provide screens of various stopping powers, for the majority of the experiments were carried out with air or carbon dioxide gaps between the source and the mica, sufficiently large to prevent the 6·97 cm. α-rays from reaching the mica.

The particles under consideration appeared to be independent of the metal on which the deposit was formed, as a check determination of the range of one set of particles, emitted from an active deposit on a platinum disc, gave a value of 11·2 cm.

It seems possible, therefore, that the 12, 13, and 10 cm. H-particles which Kirsch and Pettersson considered to arise from the collisions of α-particles from their emanation tubes with atoms of beryllium, magnesium and lithium, respectively, are actually long range α-particles emitted by the active deposit. It is of interest to note that, should the particles of range 13·2 cm. later prove to be α-particles, they will be the longest range α-particles yet discovered.

Further details of our results and experimental

arrangements will be published when we have completed the examination of the long-range particles from the active deposits of actinium and thorium.

L. F. BATES.
J. STANLEY ROGERS.

Cavendish Laboratory, Cambridge,
September 15.

The Intermediary Hosts of the Human Trematodes, *Schistosoma hæmatobium* and *Schistosoma mansoni* in Nyasaland Protectorate.

I HAVE received a letter enclosing two tubes containing specimens of five species of fresh-water molluscs from Capt. W. H. Dye, Medical Officer, Karonga, Nyasaland, British Central Africa. Capt. Dye writes: "I think I can say that the enclosed specimens represent all the fresh-water molluscs to be found in this district, as I have searched most thoroughly."

Capt. Dye was able to infect two of the species experimentally with *Schist. hæmatobium* and *Schist. mansoni* respectively.

The molluscs have kindly been identified as follows by Mr. G. C. Robson, Zoological Department, Natural History Museum, S. Kensington.

(1) *Lanistes affinis*, Smith (full grown and young).
(2) *Vivipara robertsoni*, Frauenfeld.
(3) *Limnæa natalensis*, Krauss.
(4) *Physopsis sc. globosa*, Morelet.
(5) *Planorbis sp. near sudanicus*, Martens.

Capt. Dye writes of (4) *Physopsis sc. globosa*, Morelet: "They are very common in the marshy pools, although rather difficult to find owing to their predilection for the muddy undersides of reeds, etc., and their habit of dropping off when the plant is touched. They appear to attract *S. hæmatobium* readily, and large numbers of miracidia disappear out of the tube in which they are put, against the control."

Capt. Dye goes on to describe in detail the experiments he made. He finds that the mollusc dies in two days when heavily infected with the miracidia of *Schist. hæmatobium*, after taking precautions to keep the water as free from decomposition matter as possible. The experiments were repeated several times with the same results. The snails were "not killed by *Schist. mansoni*, but one cannot get such concentration of eggs from fæces as from urine."

As to *Planorbis sp. near sudanicus*, Martens, it is referred to as "the one and only species of planorbis in this part of the world (I have most thoroughly searched). This species is not killed by a heavy infection of *Schist. hæmatobium*," but was "infected from a good heavily infected stool with *Schist. mansoni*."

Capt. Dye sent specimens of infected snails, but they died *en route* and were too decomposed for sectioning on arrival. He appears to have discovered that *Physopsis sc. globosa*, Morelet, is the intermediary host of *Schistosoma hæmatobium* in Nyasaland, and possibly he has also found the intermediary host for *Schistosoma mansoni* in Nyasaland (*Planorbis sp. near sudanicus*, Martens).

The other snails which he sent had, he stated, no attraction for either *Schist. hæmatobium* or *mansoni*.

J. B. CHRISTOPHERSON.

London, W.1.

The One-Host Life-Cycle of *Hymenolepis fraterna*, Stiles, of the Mouse.

IN the recently issued third volume of "The Practice of Medicine in the Tropics," edited by Byam and Archibald, Drs. Clayton Lane and Low call in question (on pp. 1821–2) the one-host account of the life-cycle of the well-known tapeworm *Hymenolepis fraterna*, Stiles. This account is principally based upon the work of Grassi and Rovelli and Joyeux, and it is of considerable interest and importance to be certain of the facts, not only because the vast majority of tapeworms in the higher animals most certainly require two hosts in order to complete their life-cycle, but also because these facts have a practical bearing upon the problem concerning the mode of transmission of *Hymenolepis nana* in man.

To ascertain the truth of the matter I have during the last three months selected from a large number of tame mice thirty-four individuals which I have had under close observation for periods varying between 33 and 55 days, during which the fæces had contained no Hymenolepis eggs, and from which it may be concluded that the mice were free from Hymenolepis infection. On July 20 I infected twenty of these mice with large numbers of Hymenolepis eggs obtained from naturally-infected mice, leaving the other fourteen mice as controls. Of the twenty mice infected, eighteen were found to contain cestodes in various stages of development when examined from five to twenty-four days after, one (examined only three days after) probably contained cysticeroids, and one only had apparently remained uninfected. The controls remained uninfected. Since these experiments were conducted under conditions which rendered it impossible for fleas, house-flies, or other animals to serve as intermediate hosts, and since all other necessary precautions were taken, it must be concluded that the one-host account of the life-cycle of *Hymenolepis fraterna* is the correct one. The details of these experiments will be published in full at the earliest opportunity.

W. N. F. WOODLAND.

Wellcome Bureau of Scientific Research,
London.

Polar Climate and Vegetation.

DR. STEFANSSON'S proposition, as put forth in his letter to NATURE of August 4, p. 162, that if either pole of the earth were situated in a lowland area the winter snowfall would be insufficient to produce a permanent ice-cap, is fundamentally based upon the fact that the Arctic lowlands of Canada and Siberia, with a mean annual temperature far below the freezing-point, are yet free from a summer snow-cover and permanent glaciation. This proposition is tantamount to saying that the inner north polar area is permanently glaciated because it happens to be sea, and the south polar area because it happens to be a plateau 10,000 feet high.

That this is essentially a sound conclusion will, I think, appear on a little reflection. Around the North Pole sea-ice forms during the six months night in such quantity that barely half of it can be melted during the six months day, with the consequence that even in July the mean air temperature (as given by Mohn) does not rise above $+30°$ F., or $2°$ below the freezing-point, while the mean January temperature drops to $-40°$ F.—an extreme "continental" range of temperature at a low general level conditioned by the vast expanse of floe-ice amounting to some two-thirds of the area of the polar sea. On the other hand, the mean July temperature of the Arctic lowlands varies with locality between 40° and 60° F., and, as pointed out by Dr. Stefansson, heat spells of 90° in the shade commonly occur.

The great summer cold of the Antarctic Plateau is at first sight more difficult to understand than the less severe summer cold of the Arctic Ocean. The

south polar area, being a land surface, is entirely dependent on snowfall for its glaciation, and the snowfall there is comparatively small, if only on account of the low vapour content of the air in very cold regions. Yet in spite of the exposure of the high plateau to six months' continuous summer sunshine, except in so far as clouds may sometimes obscure it, the cold continues so intense as to preserve the ice-sheet intact. In the first place, it must be remembered that the Antarctic Plateau, though extensive, is small enough to be chilled in the same way as any other mountain uplift in any latitude rising like an island into the *cold of the free atmosphere*, which is not effectively heated by the sun's rays traversing it. In the second place, the snow-surface reflects so much of the incident solar radiation that comparatively little is available for raising the temperature of the snow to melting-point. These two factors account for the severe summer cold of the Antarctic Plateau; but if the major factor were removed, that is to say, if the plateau, retaining its present horizontal extent and its present amount of snowfall, were lowered to sea-level, it is probable, as Stefansson thinks, that the ice-sheet would disappear in summer, permitting grass, or even spruce forest, to flourish, just as in the Arctic lowlands to-day.

That a reduction to sea-level of the Antarctic Plateau would remove the permanent ice-cap is the opinion, moreover, of Messrs. Priestley and Wright, as expressed in the handsome volume on the glaciology of the second Scott expedition (1910-1913), which has just been published. I do not, however, fully support Dr. Stefansson in expecting that a lowland south polar continent surrounded by an ice-chilled ocean would be liable, at least so often, to the high summer temperature of the Arctic lowlands, and for this reason. In the Arctic lowlands of Canada or Siberia hot spells in June and July may be materially assisted by the passage northward of air heated in the continental regions to the south, and on the contrary cool spells with summer frosts may be occasioned by northerly winds off the ice-chilled polar sea.

Dr. Stefansson has pointed out in his letter of August 4 that the temperature is invariably lowered in hot summer spells in the Mackenzie Valley, as compared with places in Alaska, in consequence of a persistent polar wind which blows up that valley. Now this polar wind up the Mackenzie valley in hot weather is just a local monsoon effect created by the great difference of temperature between the heated land and chilly ocean, and is precisely the predominant type of circulation one would expect to be set up by a lowland south polar continent heated by summer sunshine and encircled by an ice-chilled ocean. Instead of the present glacial anticyclone with outflowing winds, inflowing winds chilled by sea-ice would commonly flow in towards the lowland Antarctic continent and bring a good deal of cloud, rain or sleet, so that the occasions when high-air temperatures of 80° to 90° F. could occur during the southern midsummer, December and January, would be less frequent than in the circumpolar Arctic lowlands in the northern midsummer, June and July, and confined to calm clear conditions.

As regards the dependence of Arctic spruce forest on a short hot summer, Dr. Stefansson makes clearer in his "Northward Course of Empire" than in his letter of August 4, that a factor of enormous importance in high latitudes is the constant summer daylight. As a bioclimatic factor, light is equally important with warmth, and it is apt to be overlooked by climatologists that the contrast between summer and winter is just as much one of light and darkness as of heat and cold in middle latitudes and much more so in polar latitudes. Now it was shown so far back as 1893 that in cold latitudes plants require and utilise more diffuse daylight than in warm latitudes. In the Arctic lands not only is the period of continuous, or nearly continuous, daylight much longer than the period of high temperature which is limited to a few weeks, but on account of the low altitude of the sun the ratio of diffuse to direct sunlight is much greater than in the tropics, so that the intensity of diffuse daylight is relatively great, and there can be no doubt that this factor is all-important in permitting vegetation to push much farther north than would be the case if light were not able to some extent to replace warmth in the economy of plants during the Arctic summer.

The "Northward Course of Empire," reviewed in NATURE of June 23, p. 839, by Dr. H. R. Mill, was written to correct exaggerated views concerning the inhospitality of the "Frozen North," and to show the possibility of settlement in the Arctic lowlands. Many interesting philosophical questions are raised therein. For example, if Dr. Stefansson's generalisation is sound to the effect that the negro, beset on all sides by terrible parasitic enemies, can move to the Arctic and remain healthy if suitably protected from the cold, whereas the more robust Eskimo immediately sickens and dies of germ infections if brought south, because in the comparatively germ-free atmosphere of the far north he has developed no resisting power, the thoughtful reader will inquire whether the high and increasing degree of protection from infection which modern hygiene and medicine is affording to civilised races is not being purchased at the expense of that resisting power which enabled them to survive the ignorance and dangers of the past, so that dire results might follow any temporary withdrawal of the protecting hand through some emergency. At all events, it is clear that a sound medical philosophy will have an eye to the dangers of coddling no less than to those of undue exposure to adverse agencies.

L. C. W. BONACINA.

27 Tanza Road, Hampstead, N.W.3,
August 29.

Series Spectra in Oxygen and Sulphur.

A FEW months ago I wrote a paper (Abstract, *Physical Review*, 21, 710, 1923) on "New Series Spectra in Oxygen." It was read at the meeting of the American Physical Society in Washington, D.C., last April. Some questions arose there concerning these series because of their rather unusual character. Hence I re-photographed the spectra of oxygen and obtained data that confirm and extend my earlier results. I also studied the element sulphur, which resembles oxygen in its spectroscopic properties, and obtained, for the first time I think, sulphur spectra in the region of wave-lengths shorter than $\lambda 2500$.

OXYGEN.—The new series reported at Washington have been extended from two to seven and from one to six members respectively. No second member of the third series was found. In the series terms listed below, the Fowler notation is used with the modification that P is used instead of p for the common head of the new *triplet* series. This change was suggested to me by Prof. R. T. Birge. The wave numbers of the head oP_{123} of the series are 109833, 109674, and 109607. Only the shortest wave-length of each member is noted, but the others were observed and may be readily calculated from the data given here; $oP_3 - 1S$, $2S$, . . . $7S$ are λ's 1302·27, 1039·26,

976·50, 950·95, 937·85, 930·24, and 925·46 respectively; $oP_3 - 2D$, $3D$, . . . $7D$ are 1025·84, 971·76, 948·73, 936·62, 929·59, and 924·92. The wave-lengths of $oP_{23} - 1s$ are 1355·6 and 1358·6, while the $oP_1 - 1s$ line is definitely absent.

SULPHUR.—In extending the spectrum of sulphur into the extreme ultra-violet, I used dry sulphur dioxide at various pressures in both the receiver and connected discharge-tube of the vacuum grating spectrograph. The following is a brief summary of some of the results obtained. Sulphur dioxide gas has a strong absorption band extending from λ2500 to λ1700 where a narrow and relatively transparent region occurs, and then another absorption band extends from λ1650 indefinitely into the ultra-violet. The fine structure of these bands is now being studied in this laboratory. By using low pressures strong spectra have been obtained even in these regions of absorption. Thus I have photographed the spark and arc spectra of sulphur. The spark spectrum consists of many lines and groups of lines and extends to λ350. The most prominent feature of the arc spectrum is a number of triplets of wide separation and constant frequency difference. I have classified these triplets in series by analogy with oxygen. The series' designation and wave-lengths are: $oP_{123} - 1S$, 1826·35, 1820·53, 1807·42; $oP_{123} - 2S$, 1436·92, 1433·27, 1425·11; $oP_{123} - 3S$, 1326·69, 1323·58, 1316·63. $oP_{123} - 2D$, 1485·53, 1481·66, 1472·99; $oP_{123} - 3D$, 1412·92, 1409·41, 1401·55; $oP_{123} - 4D$, 1313·22, 1310·26 . . . (the last line of this triplet was not observed as it is probably hidden by the strong oxygen triplet in this region). $oP_{23} - 1s$ are at 1914·96, 1900·47, and the $oP_1 - 1s$ line is definitely missing as in oxygen. The common head oP_{123} of these series cannot be accurately calculated from the data using the Rydberg law. Fortunately the term $1s$ has been observed by Meissner (*Annalen der Physik*, 50, 713, 1916) in his study of the infra-red, hence the head of these series and all the other terms may be obtained at once from the above corresponding wave-lengths. Thus oP_{123} has the values in frequency units of 82982, 83156, and 83554. Using these values and the observed wave-lengths, $1S = 28227$, $2S = 13384$, etc. Other spectra in sulphur containing these terms would exist in the region of the infra-red and have not yet been observed.

Both the oxygen and sulphur spectra described above show similar characteristics, namely, the intensities of the lines and their separations are inverted as compared with the known spectra of these elements in the visible and infra-red, thus in the new spectra the shortest wave-length of each triplet is most intense, and, as indicated by the data above, the frequency separation is greater between the two more refrangible lines of each triplet. In both elements one triplet has a missing line correspondingly placed. This fact seems to indicate an inner quantum relation which makes its occurrence impossible.

On the new Bohr theory the valence level of oxygen and sulphur is a 2_2, hence a p or P level and my data indicate this to be a triple level. Apparently there exist one stable and two metastable forms of each of the elements atomic oxygen and atomic sulphur. On the assumption that in both elements the oP_{123} level is the valence level, the resonance and ionising potentials of the stable forms as calculated from the data above are: for the oxygen atom, resonance 9·11 volts, ionisation 13·56 volts; for atomic sulphur, resonance 6·50 volts, ionisation 10·31 volts.

J. J. HOPFIELD.

University of California, Berkeley,
August 3.

[IT should be noted that in the foregoing communication the capital letters P, S, D refer to the new triplet series, and in the case of oxygen are not connected with the previously known "singlet" series for which similar designations have been elsewhere adopted. Also, that the terms $1s$ are those associated with the previously known triplet series of oxygen and sulphur.—ED. NATURE.]

Continental Drift and the Stressing of Africa.

MR. WAYLAND in NATURE of August 25, p. 279, brings forward weighty arguments, based on the results of the Geological Survey of Uganda, to rebut the usually accepted view that the Protectorate, like most of eastern Africa, and probably western Africa as well, has been predominantly in a state of tension. I shall be surprised, however, if further work does not disclose the existence of at least some normal faulting with a north and south strike, showing the former existence of east and west tension. It may well be that compression and tension have more than once alternated with each other in Uganda. There is no reason, too, why a change of conditions may not convert a true rift valley formed in a period of tension into one bounded by reversed faults.

I am by no means prepared to admit that the birth of the moon (supposing it to have in fact arisen by separation from the earth) must have necessarily been a "piece of extremely ancient history." Sir George Darwin gives reasons for his belief that it took place considerably more than 50 or 60 million years ago. Now Dr. Holmes's calculations, based on the uranium-lead ratio of certain minerals, show an antiquity of about 500 million years for the beginning of the Cambrian. This would suggest that the interesting event in question may have occurred at some time within the limits of the fossiliferous record.

Nor is there any reason to believe that it must have been marked by stupendous catastrophic disturbances. A sphere of the earth's size yields itself slowly but practically unresistingly to a force acting continuously upon it—in this case the centrifugal force due to its rotation, accelerated more by the progressive condensation of its interior than retarded by the tidal action of the sun.

The process of separation may have been protracted over a considerable time, more perhaps than that represented by a single geological formation. Indeed, there is a great deal to be said for the suggestion that it may have commenced about the middle of the Carboniferous and continued till the close of the Trias. This would account for the fact that in the portion of the earth's crust which has been chiefly studied, that is to say the extra Pacific area, there appears to have been throughout that lengthy period a general, though by no means a complete, recession of the ocean, which would presumably be attracted towards the protruding mass of the moon. At some stages of this emergence the bulk of the atmosphere would be affected in the same way, giving rise in the region antipodal to the moon to a period of marked rarefaction and cold, resulting in the Talchir and Dwyka ice-age which has been recognised not only in South Africa, but also in India, Australia, the Falklands, and South America, all formerly according to Wegener, and I believe he is right, clustered about Africa. If there be any truth in this supposition we should expect the chief period of tension in Africa and its surroundings to have existed in Mesozoic and early Kainozoic times, not in the Palæozoic or pre-Cambrian. The powerful tidal action of the moon, while still comparatively

near the earth, would be responsible for the fact that the readjustment of the earth's crust after a large portion had been removed in the course of the formation of the moon was mainly effected in an east and west direction.

In these circumstances the excessive meridional folding which Prof. Chamberlin postulates as a necessary result of tidal retardation could not be looked for.

The chief value of the formulation of a speculative hypothesis such as I have sketched out is in illustrating and emphasising the interest and importance of detailed study of geological structures, region by region and period by period, throughout the world. It will only be when we have all the facts before us, that we shall be able to solve with any assurance the problems presented by the present configuration of the surface of the globe.

With regard to the use of the words "rift" and "rift-valley," the latter was originally and properly used by Prof. J. W. Gregory for a structural valley due essentially to tension, and I use "rift" in the corresponding sense—of a split in the earth's crust due likewise to tension. This is in close accordance with the popular and literary use of the word "rift." Should at any future time it be clearly proved that the "great rift valley" was never in the whole course of its existence associated with east and west tension, it would then, I submit, have no longer a right to the title. JOHN W. EVANS.

Imperial College of Science and Technology,
South Kensington, S.W.7,
August 31.

Stereoisomerism among Derivatives of Diphenyl.

THE cases of isomerism so far recorded among derivatives of diphenyl, whether connected with optical activity or not (Kenner and co-workers, Trans. Chem. Soc., 1922, 121, 614, etc.), are interesting from the point of view of the possibility of the existence of a stable para-bond in benzene and, more particularly, in diphenyl derivatives. Thus, any 2 : 2′-derivative of diphenyl should be capable of optical activity on the basis of the general formula :

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  /CH=CR\         /CR=CH\
CH--------C---C--------CH
  \CH=CH/         \CH=CH/
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which reveals the presence of four asymmetric carbon atoms.

From the same point of view, the isomeric dinitrobenzidines (cf. for example, Brady and McHugh, Trans. Chem. Soc., 1923, 123, 2047), and some of the substances derived from them, also contain four asymmetric carbon atoms, although this type does not include cases of optically active substances at present.

The above suggestion opens up a large field for investigation. It is interesting to note, in passing, that diphenyl forms a tetra-ozonide, which may indicate that the para-bonded condition is favoured even by the parent hydrocarbon. E. E. TURNER.

East London College,
Mile End Road, E.1,
September 4.

The Liesegang Phenomenon—an Historical Note.

THE discovery of the phenomenon of periodic stratification in gels is attributed to Liesegang (*Phot. Archiv*, 1896, 221). Historical accounts of earlier experimental work on the formation of precipitates of sparingly soluble substances in gels are given by Wo. Ostwald ("Grundriss der Kolloidchemie," Dresden, 1909, 208) and by Bradford (*Biochemical Journal*, 29, 29, 1920). The latter author states (*loc. cit.*, p. 29): "The first observation of a series of layers (produced by periodic precipitation in gels) must be ascribed to Lupton (NATURE, 47, 13 (1892))." It may be observed that Ord published experiments before this date on the formation of calcium oxalate in isinglass gels. Details of these experiments are given in his book ("The influence of Colloids upon Crystalline Form and Cohesion," London, 1879), which, in the writer's opinion, has not received the attention it deserves. It appears from the passage quoted below (*op. cit.*, p. 108) that Ord before 1879 (the actual date of the experiment is given in the text as March 12, 1869) had obtained stratified precipitates of calcium oxalate :

"The deposit (of calcium oxalate) was not uniform, but somewhat stratified, forming a layer of greatest density near the calcium solution, a layer of less density, with some opalescence, near the oxalic solution, *and several intermediate layers of still less density, with alternate spaces of extreme scantiness of deposit.*"

In the light of these facts it seems that the priority of the discovery should be taken by Ord.

J. R. I. HEPBURN.

119 Richmond Road, London, N.1,
August 18.

Urease as a Product of *Bacterium radicicola*.

THE letter by Prof. Werner in NATURE of August 11 "On the Presence of Urease in the Nodules of the Roots of the Leguminous Plants," induces me to state that urease is also produced by the pure cultures of *Bacterium radicicola*, and much more profusely than by the nodules. Such forms as *Viciæ*, *Trifolii*, *Pisi*, are particularly strong in this respect, while *Ornithopodis* and *Lupini* are but feeble urease-producers.

It is interesting to observe that urease is also, in certain cases, a product of the normal papilionaceous plants, first discovered by Takeuchi in the beans of *Soja hispida*, and by me in the seeds and the rind of the branches of *Cytisus Laburnum* and *Glycine chinensis*.

The simplest way for the demonstration of the enzyme is the plate-method which I have described in *Centralblatt f. Bakteriologie*, 2te Abt., Bd. 5, p. 323, 1893, and *Archives Néerlandaises*, 1895. As, however, *B. radicicola* does not grow well on broth-gelatin, or yeast-decoct-gelatin with $1\frac{1}{2}$ per cent. urea, the detection of the enzyme must be made with material taken from colonies previously grown on peas-leaf-gelatin, with 2 per cent. cane-sugar, and then used as little lumps, placed on the yeast-decoct-urea-gelatin plate. After a few minutes the beautiful "iris-phenomenon" becomes visible if urease is present, as a consequence of the production of ammonium-carbonate which precipitates the calcium-carbonate and calcium-phosphate in the particular manner proper to this experiment. The addition of some calcium-malate to the yeast-urea-gelatin enhances the sensibility of the iris-reaction.

The discovery of urease in *B. radicicola* was the result of experiments on the nutrition of this bacterium, performed in 1919 and 1920, with the cooperation of Mr. Ir. L. E. den Dooren de Jong at Delft. M. W. BEIJERINCK.

Gorssel, Holland.

The Study of Man.[1]

By Prof. G. Elliot Smith, F.R.S.

In this address I propose to give a sketch of the progress that has recently been made in some of the manifold branches of study concerned with the nature and history of man and his achievements, and to suggest how they can be correlated and integrated as a real science of man with a distinctive discipline.

The recent discoveries of the remains of Rhodesian man and the Nebraska tooth have added a new species and a new genus to the human family, and two continents to the known domain of its extinct members. Intensive studies of the whole series of fossil remains and comparison with the living races of *Homo sapiens* have made it possible for us to construct a family tree of the Hominidæ, and to draw certain inferences as to the nature of the evolutionary changes that have occurred within the human family since it first came into existence. From such investigations it appears that some of the features regarded as distinctive of the highest races of men are temporary phases in the lower races; and, what is much more striking, many of the anatomical traits generally supposed to be peculiar to the human family are found in new-born gorillas and chimpanzees, but are lost by these apes before they attain their maturity. Prof. Bolk, of Amsterdam, has recently been studying this remarkable phenomenon,[2] and has attempted to interpret the facts by the Batesonian paradox that man has attained the human status and the higher races have advanced a stage beyond the lower, not by the acquisition of new characters, but by inhibiting the full development of his ancestral traits. I am unable to accept my distinguished friend's speculations. For man's mental powers and the brain that makes their manifestation possible cannot be explained simply as an unveiling of possibilities dormant in his ancestors, for they are positive additions to his equipment which represent his distinctive characteristic. There is, however, this germ of truth in Prof. Bolk's claim; the apes have in many respects departed further from the primitive ancestral type than man has in that they have become more highly specialised in adaptation to a particular mode of life. They have lost not only many primitive traits that man has retained, but also the plasticity and adaptability that played a decisive part in the attainment of man's mental pre-eminence.

I propose here to submit a tentative pedigree of man's Primate ancestry based upon the results of intensive studies in comparative anatomy and embryology, and discoveries in palæontology, and to use this as the basis for a study of the progressive changes in the brain, which prepared the way for the eventual emergence of those attributes of mind which distinguish man from all other living creatures.

In the course of this inquiry we shall see that during the process of evolution man's Primate ancestors wandered from America to Europe and Asia, and that such world-wide migrations have been continued by certain of their descendants ever since, providing the new environments which weeded out those members of the order that failed to adapt themselves to new circumstances or to specialise and drop out of the race for the attainment of a higher status. Nor did this migration cease with the advent of man himself. He has ever been a wanderer upon the face of the earth; and not until the invention of civilisation did certain groups of human beings become anchored in definite localities. One of the great sources of confusion in modern anthropological discussions is the failure to distinguish between the migration of population and the diffusion of culture: in other words due recognition is not given to the fact that a small group of people of a higher culture can impose the latter upon a large community without necessarily effecting any recognisable change in the physical characters of the people as a whole.

The Discovery of Tutankhamen's Tomb.

When the programme for the British Association meeting was first tentatively drafted, more than six months ago, the attention of the world at large was fixed upon the Theban Valley of the Tombs of the Kings, and the name of the insignificant pharaoh Tutankhamen was on every one's lips. The officers of the Association then decided that the evening lecture should be devoted to an exposition of the scientific results of the exploration of Tutankhamen's tomb, and it was hoped that Lord Carnarvon would have presided at it. I need not dwell upon the tragic events which have made impossible the realisation of either of these proposals. Lord Carnarvon's death has dealt a very serious blow to Egyptian studies just at the moment when it is more than ever important that British prestige in Egypt as a serious patron of archæological study should be maintained and strengthened.

The work in Tutankhamen's tomb has yielded singularly little information of direct scientific value. Yet there are certain aspects of this dazzling illumination of the last phase of the eighteenth dynasty that are worthy of attention. I need not emphasise the value of this discovery in forcing upon the attention of the world the vastness of the achievements of the ancient Egyptians in the fourteenth century B.C. At a time when some of us have been trying to impress this fact upon students of anthropology one cannot refrain from acknowledging the debt to Mr. Howard Carter for having accomplished in one winter what we have been striving in vain to do at the British Association for more than twelve years. There is only one point in connexion with this discovery to which I can refer before I turn to consider other aspects of the study of man.

The Search for Gold.

The vast quantity of gold actually found in the tomb is a point of special interest, for it raises problems of the utmost significance with reference to the part played by this relatively useless yellow metal in the history of civilisation. At a time when we have lost the use of gold as currency it is interesting to contemplate a stage

[1] Evening lecture delivered to the British Association Meeting at Liverpool, on September 14.

[2] L. Bolk, "The Part played by the Endocrine Glands in the Evolution of Man," *The Lancet*, September 10, 1921, p. 588.

in history before gold coinage was invented, although the metal was being used as tribute. Gold was the first metal used by man, and it was the arbitrary value attached to it for its supposed magical properties as an elixir of life that initiated the world-wide search for it which has now lasted for sixty centuries, although the motive for the search—in other words, the reason for attaching so peculiar a value to the soft yellow metal—has changed. The search for gold has been the most potent influence in the development and the spread of civilisation. From the pictures in the tomb of Tutankhamen's viceroy Huy, we learn that the gold was obtained from Nubia and the Soudan, and we are also shown the peculiar types of ships which brought this tribute down the Nile. The demonstration of the effects of such exploitation upon the Soudan has recently been revealed by the investigations of Prof. Reisner, which have provided us with an object lesson in the process of cultural diffusion such as has been happening in every part of the world since then. In modern times we have seen it in the Transvaal, in Australia, and in California—the settlement of relatively small bands of miners to get gold and incidentally to plant in hitherto waste places of the earth certain of the elements, good and bad, of our civilisation. In the Soudan thirty-five centuries ago the Egyptians were doing what our own people are now doing in the Transvaal. A relatively small band of people of higher culture were making use of the local population to exploit the gold to which the latter had previously attached no value. As the result of the settlement of cultured immigrants in their midst certain of their customs and beliefs were adopted by the indigenous inhabitants and blended with their own customs. In a report upon Prof. Reisner's work in the Soudan which I submitted to the British Association in 1915 (Report, p. 189) the facts relating to this racial and cultural mixture were summarised.

The geographical distribution of archæological remains and the features of the culture reveal to every one who is willing to read the plain story told by these facts, first emphasised by Mr. W. J. Perry, that the same process has been going on ever since the first civilisation was invented, and that it has been the chief motive for the diffusion of culture throughout the world. Whether one examines the distribution of the earliest monuments in Southern India, or the settlements mentioned in the Rig Veda in the North-West, the distribution of ancient settlements in Persia, Siberia, the Caucasus and Asia Minor, or further afield from the ancient East in Europe and the British Isles, in Africa to the Niger and Zimbabwe, in the lands of gold in Malaysia and Eastern Asia, and further still in America, we can read the same story, the same motive and the same result of the exploitation of the local natural resources by the native population under the direction of relatively small bands of alien immigrants.

Many other materials to which a magical or economic value was attached played a part in this process of exploitation. Resin, timber, pearls, copper, flint, jade, turquoise, lapis lazuli, amber, tin, and eventually all metals, were some of the more obtrusive lures that impelled men to embark upon any adventure, however hazardous: and the search for these things was responsible for the world-wide diffusion of culture.

The investigation of the details of these events throws new light upon ancient history and affords a convincing explanation of much that hitherto has been obscure in the history of civilisation.

Ancient Mariners.

Considerations of time will permit me to refer only to one aspect of this world-wide diffusion. The pictures of the boats used by Tutankhamen's viceroy reveal certain peculiar features which were adopted also in sea-going ships in the Mediterranean and Erythræan Seas. These distinctive methods of ship-building have been preserved until the present day in the Victoria Nyanza in East Africa and in certain parts of the Malay Archipelago. They are also revealed in quite unmistakable fashion in sculptures of the Early Bronze Age in Sweden. Here there is a specific illustration not only of the fact of the world-wide diffusion of culture but also of the chief means by which it was effected.

The New Vision in Anthropology.

The investigation of the factors involved in this demonstration of the unity of civilisation brings to light the motives that prompted its origin, and provides us with a new insight into the real meaning of customs and beliefs. It contains the germ of a new method of approach to the problems of psychology, and a means whereby in time the unification of anthropology will be effected and a real science of man created.

During the last twelve years there has been a profound change in most of the fields of investigation concerned with the study of man. Not only has there been a rich harvest of new facts and a fuller understanding of the meaning of such knowledge as we possess, but also there has begun to emerge a radically new attitude toward the problems awaiting solution. Hitherto the investigator who concerns himself with the problems of human structure and function, of the races of man, of the fossil remains of man, of evolution and inheritance, as a rule has refused to discuss customs and beliefs, arts and crafts, social organisation, and the psychological aspects of anthropology which are now commonly called cultural. The two branches of anthropology have been cultivated in water-tight compartments, and the fact that the results achieved in each of them have far-reaching significance for the interpretation of the problems of the other is as a rule totally ignored.

During recent years some of the more far-seeing students of man have been insisting upon what the late Dr. Rivers called the unity of anthropology and the urgency of the need for more co-operation between the different fields of research.[3] Until such integration is effected there can be no real science of man. In this address I propose to give a sketch of the new trends in anthropological thought, and to suggest how they may be unified and focussed upon a definite aim, the interpretation of man's history and human conduct.

Perhaps a simple illustration will explain the value of the correlation of physical and cultural studies. Twelve years ago, when attempting to interpret the

[3] W. H. R. Rivers, "The Unity of Anthropology," *Journ. Royal Anthropological Institute*, 1922; also B. Malinowski on the same subject, Nature, Sept. 1, 1923, p. 314.

results of the study of ancient Egyptian remains, I plotted out on a map the geographical distribution of an alien people with easily recognisable distinctive features that began to make its way into the Egyptian Delta about 3400 B.C.[4] This people, which played a definite part in Egypt, Babylonia, Crete, and the Mediterranean, and especially in Britain, could be traced without much difficulty to its homeland in Western Asia. Having reached this stage in interpreting the facts, I was greatly perturbed to find that this same unmistakable type was found widespread throughout Polynesia. Having failed to get any help or encouragement from anthropologists, either on the physical or the cultural side, to pursue this subject further, I had no alternative than to resort to ethnological studies to see whether I could not discover cultural evidence to shed some light upon the undoubted facts of race, concerning which I was satisfied that I had unshakable evidence of a widespread migration of people. In Polynesia I found the same general associations between the distribution of these distinctive people and the practices of megalith-building and mummification as I had previously found in the Mediterranean area and Western Asia; and when the evidence came to be studied intensively it seemed to establish upon unshakable foundations the fact of the unity of civilisation and the world-wide diffusion of culture in early times. This conclusion of course has been warmly contested during the last ten years, during which, however, its opponents have repeatedly shifted their ground and taken up new lines of defence. While there is not a scrap of doubt as to the ultimate issue, it is clear that there will be a prolonged conflict such as in the past was necessary to convince people that the earth was not flat, or that man was really evolved from a Simian ancestor.

There are two points in connexion with this theory that I want specially to mention:—(*a*) Its bearing upon the problems of physical anthropology, and (*b*) its relation to psychology. If it can be demonstrated that at certain scattered localities widespread throughout the world the germs of the common civilisation were planted by immigrants, the recognition of the presence of the latter at some places and not at others is a fact of cardinal importance to the student who is attempting to interpret the puzzling results of the intensive study of race in localised areas. When one is dealing with regions like Oceania, where the population is the result of relatively recent immigrations, probably none of them more than twenty centuries old, such considerations are clearly the essence of the whole problem.

I need say no more in justification of the fundamental importance of the close correlation of the work in physical and cultural anthropology. They are parts of one and the same problem, which cannot be solved unless both classes of evidence are given their proper value.

One of the greatest obstacles that has barred the way to such collaboration has been the persistent refusal on the part of ethnologists to distinguish between diffusion of culture and migration of people. The confusion that has arisen from this issue has had far-reaching effects not merely upon the interpretation of the early history of civilisation, but also by implication in creating a bias in favour of the untenable hypothesis that there is a necessary connexion between race and culture.

The proof of the fact of this widespread diffusion of ancient culture is provided (*a*) by the positive evidence that it did occur; (*b*) by the fact that in the history of custom and invention knowledge invariably has spread in the way we postulate, and has ever been the chief incentive to progress in the new foci; and (*c*) by the psychology of invention. If then, it is asked, the fact of diffusion is so certain, why is there so intense an opposition to its admission? Why do the majority of anthropologists cling to a theory that is so obviously false? Their attitude and methods of evasion become more intelligible if one goes back three centuries ago and studies the arguments of the people who refused to admit the error of the flat-earth hypothesis. If it be urged that the opposition in that case was essentially theological, it can be claimed that mediæval theology has not a monopoly of dogmatism against the advancement of science. The errors of ethnological doctrine that still hold the field are largely the outcome of certain incidents in the sixties of the nineteenth century, as the result of which (*a*) the terms used by biologists in the Darwinian controversy were misunderstood and misapplied, and (*b*) in the conflict with such apologists as Archbishop Whately and the Duke of Argyll [5] the ethnologists not only made claims that recent research has shown to be wholly indefensible, but also laid down these false doctrines with all the pontifical air of infallibility which unconsciously they seem to have adopted from their theological opponents. In recent times the attempt has been made to bolster up this false claim by certain specious psychological arguments; and the best hope for ridding anthropological science of so serious a hindrance to progress is to be found in the adoption of serious psychological methods in the investigation of customs and beliefs and the interpretation of the history of civilisation. Nor would the benefit of this closer correlation between ethnology and psychology be one-sided. Psychology has at least as much to gain as ethnology. For the investigation of the meaning of myth and folk-lore, of custom and belief, is coming to play an increasing part in the study of human behaviour. The further development of this tendency is certain to be the chief factor in ridding anthropological studies of the encumbrances of error which still hamper their growth.

MAN'S DISTINCTIVE ATTRIBUTE.

The study of man can only become transformed into a real science when man's really distinctive attribute, the nature of the human mind, is made the chief subject of anthropological inquiry. The value of psychology as the great integrating factor in anthropology has recently been explained with great lucidity by Dr. Malinowski, and in the rest of my address I want to suggest that the extent of its possibilities for effecting co-ordination is even much wider than the claims he made for it. Psychology can become the bond of union between all branches of anthropological inquiry and the medium whereby a distinctive dis-

[4] "The Ancient Egyptians," 1911 and 1923.

[5] Andrew D. White, "A History of the Warfare of Science," etc., vol. i., p. 305 (1920 ed.).

cipline can be developed to justify the creation of a real science of man.

The full recognition of the mechanism of the diffusion of culture involves a new orientation in psychological investigation, for it points the way to the true explanation of the origin of folk-lore and myth and of custom and belief; and it throws a new light upon the springs of human action and upon the problems of social and political organisation and of education. The outcome of this new movement in ethnology will be to effect a closer bond of union with real psychology and through psychology with the biological sciences that are essential for the full appreciation of the meaning of mental evolution.

It is too often forgotten by students of man's evolution that the fundamental distinctive feature of the human family is the nature and range of the powers of mind, which differentiate it from all other living creatures. The chief aim of the interpreter of this evolution should be to offer some explanation of how these distinctively human attributes were acquired.

With his usual facility of expression Sir James Frazer puts this view with great force. It is all the more welcome because he, who so freely uses the theory of the independent evolution of belief, reproves another ethnologist for too exclusive a devotion to biological methods of interpretation and for forgetting "the part that human thought and will have played in moulding human destiny." He says that some of his colleagues "would write the history of man without taking into account the things that make him a man and discriminate him from the lower animals. To do this, to adopt a common comparison, is to write the play of 'Hamlet' without the Prince of Denmark. It is to attempt the solution of a complex problem while ignoring the principal factor which ought to come into the calculations. It is, as I have already said, not science but a bastard imitation of it. For true science reckons with all the elements of the problem which it sets out to solve. . . . In particular, the science which deals with human society will not, if it is truly scientific, omit to reckon with the qualities which distinguish man from the beasts." [6]

It should, then, be the fundamental aim of any movement to integrate the forces of anthropological inquiry to provide an explanation of how man acquired his distinctive position and how precisely his behaviour was modified by the attainment of such heightened powers of discrimination and ability to profit from his experience.

THE EVOLUTION OF THE HUMAN BRAIN.

Intensive research in comparative anatomy and embryology and discoveries in palæontology have made it possible for us to reconstruct man's pedigree with a confidence that hitherto would not have been justifiable. Using this scheme as a foundation, we can determine precisely what structural changes, especially in the brain, were effected at each stage of the progress of the Primates toward man's estate; and in the light of the information afforded by physiology and clinical medicine we are able in some measure to interpret the meaning of each of the stages in the attainment of the distinctively human attributes of mind.

[6] "Totemism and Exogamy," 1910, p. 98.

In an address delivered at the Dundee meeting of the British Association eleven years ago, and elsewhere on several occasions since then, I have discussed this problem: but I make no apology for returning to its consideration again. For, as I have said already, it is the fundamental question in the study of man; and recent research has cleared up many difficult points since I last spoke on the subject.

Even before the beginning of the Tertiary period the trend had already been determined for that particular line of brain development, the continuation of which eventually led to the emergence of man's distinctive attributes. Moreover, man, as I said in 1912, is "the ultimate product of that line of ancestry which was never compelled to turn aside and adopt protective specialisations, either of structure or mode of life, which would be fatal to its plasticity and power of further development."

VISION THE FOUNDATION OF MAN'S MENTAL POWERS.

The first step was taken when in a very primitive and unspecialised arboreal mammal vision became the dominant sense, by which its movements were guided and its behaviour so largely determined. One of the immediate results of the enhancement of the importance of vision was to awaken the animal's curiosity concerning the things it saw around it. Hence it was prompted to handle them, and its hands were guided by visual control in doing so. This brought about not merely increased skill in movement, but also the cultivation of the tactile and kinæsthetic senses, and the building up of an empirical knowledge of the world around it by a correlation of the information obtained experimentally by vision, touch, and movement. The acquisition of greater skill affected not merely the hands but also the cerebral mechanisms that regulate all movements; and one of the ways in which this was expressed was in the attainment of a wider range and an increased precision of the conjugate movements of the eyes, and especially of a more accurate control of convergence. This did not occur, however, until the flattening of the face (reduction of the snout) allowed the eyes to come to the front of the head and look forward so that the visual fields overlapped. Moreover, a very complicated mechanism had to be developed in the brain before these delicate associated movements of the eyes could be effected. The building-up of the instrument for regulating these eye-movements was the fundamental factor in the evolution of man's ancestors, which opened the way for the wider vision and the power of looking forward that are so pre-eminently distinctive of the human intellect. Our common speech is permeated with the symbolism that proclaims the influence of vision in our intellectual life.

The first stage in this process seems to have been the expansion of the prefrontal cortex and the acquisition of the power of voluntarily extending the range of conjugate movements of the eyes and focussing them upon any object. Then came the laborious process of building up in the mid-brain the instrument for effecting these complex adjustments automatically,[7] so that the animal was then able to fix its gaze upon an object and

[7] John I. Hunter, "The Oculomotor Nucleus in Tarsius and Nycticebus," *Brain*, 1923.

to concentrate its attention upon the thing seen rather than upon the muscular act incidental to the process of seeing it. This represents the germ of attention and of mental concentration in general. But the power of automatically moving the eyes with such accuracy that the images of an object upon the two retinæ could be focussed with precision upon exactly corresponding spots made possible the acquisition of stereoscopic vision, the ability to appreciate the form, size, solidity, and exact position in space of objects. It also prepared the way for the development in each retina of a particularly sensitive spot, the macula lutea, which enabled the animal to appreciate the texture, colour, and other details of objects seen with much more precision than before. Hence probably for the first time in the history of living creatures an animal acquired the power of "seeing" in the sense that we associate with that verb. The attainment of these new powers of exact vision further stimulated the animal's curiosity to examine and handle the objects around it and provided a more efficient control of the hands, so that acts of increasing degrees of skill were learned and much more delicate powers of tactile discrimination were acquired. Out of these experiments also there emerged a fuller appreciation of the nature of the objects seen and handled and of the natural forces that influenced the course of events.

With the acquisition of this new power of learning by experimentation, events in the world around the animal acquired a fuller meaning; and this enriched all its experience, not merely that which appealed to the senses of sight and touch, but hearing also. Thus in the series of Primates there is a sudden expansion of the acoustic cortex as soon as stereoscopic vision is acquired, and the visual, tactile, motor and prefrontal cortex also feel the stimulus and begin rapidly to expand. This increase of the auditory territory is expressed not only in a marked increase of acoustic discrimination but also by an increase in the power of vocal expression. At a much later stage of evolution the fuller cultivation of these powers conferred upon their possessors the ability to devise an acoustic symbolism capable of a much wider range of usefulness than merely conveying from one individual to another cries expressive of different emotions. For when true articulate speech was acquired it became possible to convey ideas and the results of experience from individual to individual, and so to accumulate knowledge and transmit it from one generation to another. This achievement was probably distinctive of the attainment of human rank, for the casts obtained from the most primitive brain-cases, such as those of Pithecanthropus and Eoanthropus, reveal the significant expansion of the acoustic cortex. This new power exerted the most profound influence upon human behaviour, for it made it possible for most men to become subject to tradition and to acquire knowledge from their fellows without the necessity of thinking and devising of their own initiative. It is easier to behave in the manner defined by convention than to originate action appropriate to special circumstances.

Within the limits of the human family itself the progressive series of changes that we have witnessed in man's Primate ancestors still continue; and as we compare such a series of endocranial casts as those of Pithecanthropus, Eoanthropus, *Homo rhodesiensis*, *Homo neanderthalensis*, and *Homo sapiens*, we can detect a progressive expansion of the parietal, prefrontal, and temporal territories, which are associated with the increasing powers of manual dexterity and discriminative power, of mental concentration and of acoustic discrimination.

The study of such factors of cerebral development will eventually enable us to link up the facts of comparative anatomy with psychology, and enable us the better to understand human behaviour. Such wider knowledge will, in time, help us to co-ordinate the principles that underlie customs and beliefs, and from such researches there will eventually emerge a distinctive discipline and a more strictly scientific method.

For the full realisation of this vision, what is necessary above all is that the universities should recognise the importance of this new conception of humane studies and take an active part in building up a science of man that is more scientific than what at present are known as the humanities and more human than biology. The fundamental aim of all education is the fuller understanding of the forces of Nature and of human behaviour. The necessity for attacking the latter problem with more directness and precision is urgent; and it is impossible to exaggerate the importance of a fuller cultivation in our universities of the study of the nature of man and of the springs of human conduct. It lies at the root of all knowledge and the intelligent control of all human affairs. I need not emphasise the tremendous practical importance of such studies to an Empire such as ours at the present time. The Pan-Pacific Conference held in Australia recently is an earnest of the realisation of this fact by statesmen and administrators and of the usefulness of collaborating with men of science to acquire an understanding of subject peoples and their social problems. This policy of peaceful development of the Pacific is a good augury for the fuller recognition of the value of anthropology to the world at large.

Some Bearings of Zoology on Human Welfare.[1]

By Prof. J. H. ASHWORTH, D.Sc., F.R.S.

THE bearings of zoology on human welfare—as illustrated by the relation of insects, protozoa, and helminthes to the spread or causation of disease in man—have become increasingly evident in these later years, and are familiar to every student of zoology or of medicine. At the time of the last meeting of the British Association in Liverpool (1896), insects were suspected of acting as transmitters of certain pathogenic organisms to man, but these cases were few, and in no single instance had the life-cycle of the organism

[1] From the presidential address delivered to Section D (Zoology) of the British Association at Liverpool on September 13.

been worked out and the mode of its transmission from insect to man ascertained. The late Sir Patrick Manson, working in Amoy, had shown (1878) that the larvæ of *Filaria bancrofti* undergo growth and metamorphosis in mosquitoes, but the mode of transference of the metamorphosed larvæ was not determined until 1900. Nearly two years after the last meeting in Liverpool the part played by the mosquito as host and transmitter of the parasite of malaria was made known by Ross. In addition to these two cases, at least eight important examples can now be cited of arthropods proved to act as carriers of pathogenic organisms to man—*e.g.* Stegomyia—yellow fever; Phlebotomus—sandfly fever; tsetse-flies—sleeping sickness; Conorhinus—South American trypanosomiasis (Chagas' disease); Chrysops—*Filaria* (*Loa*) *loa*; the flea *Xenopsylla cheopis*—plague; the body-louse—trench fever, relapsing fever, and typhus; and the tick Ornithodorus—African relapsing fever.

In selecting examples for brief consideration I propose to deal very shortly with malaria, although it is the most important of the insect-carried diseases, because the essential relations between the Anopheles mosquito and the parasite are well known. There still remain lacunæ in our knowledge of the malarial organisms. Ross and Thomson (1910) showed that asexual forms of the parasite tend to persist in small numbers between relapses, and suggested that infection is maintained by these asexual stages. Such explanation elucidates those cases in which relapses occur after short intervals, but the recurrence of the attacks of fever after long intervals can only be explained by assuming that the parasites lie dormant in the body—and we know neither in what part of the body nor in what stage or condition they persist. Nevertheless, the cardinal points about the organism are established, and preventive measures and methods of attack based on a knowledge of the habits and bionomics of Anopheles have been fruitful in beneficial results in many parts of the world.

If we desire an illustration of the vast difference to human well-being between knowing and not knowing how a disease-germ is transmitted to man, we may turn to the case of yellow fever. When this pestilence came from the unknown, and no one knew how to check it, its appearance in a community gave rise to extreme despair, and in many cases was the signal for wholesale migration of those inhabitants who could leave the place. But with the discovery that Stegomyia was the transmitting agent all this was changed. The municipality or district took steps to organise its preventive defences against a now tangible enemy, and the successful issue of these efforts, with the consequent great saving of life and reduction of human suffering in the Southern United States, in Panama, in Havana, and in other places, is common knowledge. It is a striking fact that during 1922 Central America, the West Indies, and all but one country of South America were free from yellow fever, which had ravaged these regions for nearly two centuries. The campaign against Stegomyia is resulting, as a recent Rockefeller report points out, in yellow fever being restricted to rapidly diminishing, isolated areas, and this disease seems to be one which by persistent effort can be brought completely under control.

In 1895 Bruce went to Zululand to investigate the tsetse-fly disease which had made large tracts of Africa uninhabitable for stock, and near the end of the same year he issued his preliminary report in which he showed that the disease was not caused by some poison elaborated by the fly—as had been formerly believed—but was due to a minute flagellate organism, a trypanosome, conveyed from affected to healthy animals by a tsetse-fly (*Glossina morsitans*). In 1901 Forde noticed an active organism in the blood of an Englishman in Gambia suffering from irregularly intermittent fever, and Dutton (1902) recognised it as a trypanosome, which he named *Trypanosoma gambiense*. In 1902 Castellani found trypanosomes in the blood and cerebrospinal fluid of natives with sleeping sickness in Uganda, and suggested that the trypanosome was the causal organism of the disease. The Sleeping Sickness Commission (Bruce and his colleagues) confirmed this view, and showed that a tsetse-fly, *Glossina palpalis*, was the transmitter. Since then much has been learnt regarding the multiplication of the trypanosome in the fly and its transference to man. For some years this was believed to take place by the direct method, but in 1908 Kleine demonstrated "cyclical" transmission, and this was shown later to be the principal means of transference of *T. gambiense*. In 1910 Stephens and Fantham described from an Englishman, who had become infected in Rhodesia, a trypanosome which, from its morphological characters and greater virulence, they regarded as a new species, *T. rhodesiense*, and its "cyclical" transmission by *Glossina morsitans* was proved by Kinghorn and Yorke. Recent reports by Duke and Swynnerton (1923) of investigations in Tanganyika Territory suggest that direct rather than cyclical transmission by a new species of Glossina is there mainly responsible for the spread of a trypanosome of the *T. rhodesiense* type.

The impossibility of distinguishing by their morphology what are considered to be different species of trypanosomes, and the difficulty of attacking the fly, are handicaps to progress in the campaign against sleeping sickness, which presents some of the most subtle problems in present-day entomology and protozoology. Here also we come upon perplexing conditions due apparently to the different virulence of separate strains of the same species of trypanosome and the varying tolerance of individual hosts—on which subjects much further work is required.

The relation of fleas to plague provides one of the best and most recent illustrations of the necessity for careful work on the systematics and on the structure and bionomics of insects concerned in carrying pathogenic organisms. Plague was introduced into Bombay in the autumn of 1896, and during the next two years extended over the greater part of Bombay Presidency and was carried to distant provinces. The Indian Government requested that a commission should be sent out to investigate the conditions. The commission, which visited India in 1898–99, came to the conclusion (1901) that rats spread plague and that infection of man took place through the skin, but—and this is amazing to us at the present day—"that suctorial insects do not come under consideration in connection with the spread of plague." Further observations, however, soon showed this conclusion to be erroneous. Liston found in Bombay in 1903 that

the common rat-flea was *Pulex* (*Xenopsylla*) *cheopis*, that it was present in houses in which rats had died of plague and in which some of the residents had become infected, that the plague-bacillus could multiply in the stomach of this flea, and that the flea would—in the absence of its usual host—attack man. These observations pointed to the importance of this flea in the dissemination of plague, and the Second Plague Commission, which was appointed and began work in 1905, definitely proved that *Xenopsylla cheopis* is the transmitter of the plague-organism from rat to rat and from rat to man.

The mechanism of transmission of the plague-bacillus was worked out by Bacot and Martin in 1913. They showed that in a proportion of the fleas fed on the blood of septicæmic mice the plague-bacilli multiply in the proventriculus—which is provided with chitinous processes that act as a valve to prevent regurgitation of the blood from the stomach—and a mass of bacilli is formed which blocks the proventriculus and may extend forward into the œsophagus. Fleas in this condition are not prevented from sucking blood, because the pharynx is the suctorial organ, but their attempts to obtain blood result only in distending the œsophagus. The blood drawn into the œsophagus is repeatedly forced backwards into contact with the mass of plague-bacilli, and on the sucking action ceasing some of this infected blood is expelled into the wound. The transmission of plague depends on the peculiar structure of the proventriculus of the flea and on the extent to which, in certain examples, the plague-bacilli multiply in the proventriculus. Such "blocked" fleas being unable to take blood into the stomach are in a starved condition, and make repeated attempts to feed, and hence are particularly dangerous.

Until 1913 it was believed that all the fleas of the genus Xenopsylla found on rats in India belonged to one species (*cheopis*), but in that year L. F. Hirst reported that the rat-flea of Colombo was *X. astia*, which had been taken off rats in Rangoon, and described by N. C. Rothschild in 1911. Hirst ascertained that this flea did not readily bite man if the temperature were above 80° F. A collection of 788 fleas from Madras City proved to consist entirely of *X. astia*, and Hirst suggested that the explanation of the immunity of Madras and Colombo from plague was the relative inefficiency of *X. astia* as a transmitter. Cragg's examination (1921, 1923) of 23,657 fleas obtained from rats in all parts of India shows that they include three species: *Xenopsylla cheopis*, *X. astia*, and *X. brasiliensis*. This last species is common in the central and northern uplands of peninsular India, but its bionomics have not yet been investigated. *X. cheopis* is the predominant species in the plague areas, while *X. astia* is the common flea in those areas which have remained free from plague or have suffered only lightly. In Madras City, for example, during the twenty-one years, 1897–1917, plague has occurred in twenty of these years, but the average mortality was only 0·013 per thousand—that is, though the infection has been repeatedly introduced there, it failed each time to set up an epidemic. The significance of an imported case of plague depends in large measure on the local species of Xenopsylla. Hirst has made numerous attempts during the plague season in Colombo to transmit plague by means of *X. astia* from rat to rat, but with negative results, and *X. astia* was never found to behave like a "blocked" *X. cheopis*.

The distinction of *X. cheopis* from *X. astia* is not an entomological refinement with purely systematic significance, but corresponds with a different relation of the species to the epidemiology of plague, and hence becomes a factor of great practical importance. If through these researches it has become possible by examination of the rat-fleas of a locality to estimate accurately its liability to plague, anti-plague measures may henceforward be restricted to those areas in which plague is likely to occur, *i.e.* where *X. cheopis* is the predominant flea. Thus a great economy of effort and of expenditure and a higher degree of efficiency may be achieved; in fact, the problem of the prevention or reduction of plague may be brought from unwieldy to practicable proportions. When it is remembered that since 1896 some ten and a quarter millions of people have died in India from plague, we have a more than sufficient index of the importance of a precise knowledge of the systematics, structure, and bionomics of the insect-carrier of *Bacillus pestis*.

Another of the outstanding features of the period under review has been the extensive and intensive study of the Protozoa. The structure and the bionomics and life-history of these organisms have been investigated with the help of the finest developments of modern technique. It is fitting here to record our acknowledgment to two staining methods—Heidenhain's iron-hæmatoxylin and the Romanowsky stain (including Giemsa's and Leishman's modifications), which have added greatly to our technical resources.

There is time to refer only to certain of the Protozoa which directly affect man. Twenty years ago our knowledge of the few species of Protozoa recorded from the human alimentary canal was defective in two important respects—the systematic characters and the biology of the species—so there was much confusion. Subsequent investigations, and especially those of the last ten years (by Wenyon, Dobell, and others), have cleared up most of the doubtful points, but owing to the difficulties of size and the paucity of characters available, it is by no means easy in practice to distinguish certain of the species. Of the seventeen species now known to occur in the intestine of man, *Entamœba histolytica* has received particular attention. This organism lives as a tissue parasite in the wall of the large intestine, where, as a rule, the damage caused is counterbalanced by the host's regenerative processes. But when the destruction outstrips the regeneration intestinal disturbance results, leading to the condition known as amœbic dysentery. The specific characters and the processes of reproduction and encystment of *E. histolytica* are now well ascertained, and it is realised that in the majority of cases the host is healthy, acting as a "carrier" dangerous to himself, for he may develop into a case of acute dysentery, and to the community—for he is passing in his fæces the encysted stage which is capable of infecting other persons. Whether an infected person will suffer from dysentery or act as a healthy "carrier" apparently depends upon his own susceptibility rather than on any difference in the virulence of different strains of the Entamœba.

In all work with Entamœbæ infecting human beings

there is need for critical determination of the species, for, in addition to *E. histolytica*, a closely similar species, *E. coli*, is a common inhabitant of the intestine. This, however, is a harmless commensal, feeding on bacteria and fragments derived from the host's food. The distinction between the two species rests chiefly upon the characters of the nuclei and of the mature cyst—quadrinucleate in *E. histolytica* and octonucleate in *E. coli*—and considerable care and technical skill are requisite in many cases before a diagnosis can be given. Yet this distinction is definitely necessary in practice, for indiscriminate treatment of persons with Entamœba is indefensible; treatment is only for those with *E. histolytica*; it is useless for those with *coli*, and subjects them needlessly to an unpleasant experience.

A notable result of recent work is the proof that the more common intestinal Protozoa, formerly believed to be restricted to warmer countries, occur indigenously in Britain. This was first established by a group of observers in Liverpool, and has been confirmed and extended by subsequent workers. There is good reason for believing that in Great Britain the incidence of infection with *E. histolytica* is about 7 to 10 per cent., and with *E. coli* about five times as great (Dobell).

The discovery (1903) of Leishmania, the organism of kala azar and of oriental sore, added another to the list of important human pathogenic Protozoa, but the mode of transmission of this flagellate has not yet been proved.

Of the problems presented by the parasitic worms, the most momentous are those associated with Ancylostoma and its near relative Necator, which are prevalent in countries lying between 36° N. and 30° S.—a zone which contains more than half the population of the earth. Heavy infection with Ancylostoma or with Necator produces severe anæmia, and reduces the host's physical and mental efficiency to a serious degree. Until 1898 there was no suggestion that infection was acquired in any other way than by the mouth, but in that year Looss published his first communication on the entry of the larvæ of Ancylostoma through the skin, and in 1903 gave an account of further experiments which proved that dermal infection resulted in the presence of worms in the intestine. At the meeting of the British Association in Cambridge in 1904 Looss demonstrated to a small company his microscopical preparations showing the path of migration of the larvæ. His investigations served to establish the importance of the skin as the chief portal of entry of Ancylostoma, and pointed the way to effective methods of prevention against infection.

Another notable advance in helminthology is the working out of the life-cycle of Schistosoma (Bilharzia)—a genus of trematode worms causing much suffering in Egypt and elsewhere in Africa, as well as in Japan and other parts of the world. These worms when mature live in pairs, a male and female, in the veins of the lower part of the abdomen, especially in the wall of the bladder and of the rectum. The eggs, laid in large numbers by the female worm, provoke inflammatory changes, and cause rupture of the veins of the organs invaded. Until about ten years ago the life-history of Schistosoma had been traced only as far as the hatching of the ciliated larva or miracidium, which takes place shortly after the egg reaches water, but it was then shown that this larva is not, as had been held by Looss, the stage which infects man. Miyairi and Suzuki (1913) found that the miracidium of *Schistosoma japonicum* entered a fresh-water snail which acted as the intermediate host, and Leiper and Atkinson (1915) confirmed and extended this observation, and showed that the miracidia develop into sporocysts in which cercariæ are formed. We owe chiefly to Leiper's work (1915–16) our knowledge of the life-history and method of entry into man of the Egyptian species of Schistosoma. He demonstrated that two species of this parasite occur in Egypt, and established that the miracidia develop in different intermediate hosts: those of *S. mansoni* enter Planorbis, while those of *S. hæmatobium* penetrate into Bullinus—the molluscs being abundant in the irrigation canals. The sporocysts produce cercariæ, which escape from the snails and gather near the surface of the water, and experiments with young mice and rats showed that the cercariæ attach themselves to the skin, enter, and reach the portal system, from which they travel to the veins of the lower part of the abdomen. Infection of man takes place chiefly through the skin when bathing or washing in water containing the cercariæ, though infection may also occur through drinking such water. So, at last, these worms which have troubled Egypt for at least thirty centuries have become known in all their stages, and measures for preventing infection—which were of great use during the War—have been devised, and curative treatment introduced.

Other recent helminthological researches deserve consideration did space permit, for there has been much excellent work on the life-history of the liver-flukes and lung-flukes of man, and the life-cycle of the tape-worm, *Dibothriocephalus latus*, was worked out in 1916–17. Mention should also be made of Stewart's investigations (1916–19) on the life-history of the large round-worm *Ascaris lumbricoides*, during which he made the important discovery that the larvæ on hatching in the intestine penetrate into the wall and are carried in the blood to the liver, and thence through the heart to the lungs, where they escape from the blood-vessels, causing injury to the lungs. The larvæ, now about ten times their original size, migrate by way of the trachea and pharynx to the intestine, where they grow to maturity. During last year Dr. and Mrs. Connal have worked out the life-history of *Filaria* (*Loa*) *loa* in two species of the Tabanid fly, Chrysops, and investigations on other Filarias have thrown light on their structure, but there is still need for further researches on the conditions governing the remarkable periodicity exhibited by the larvæ of some species (*e.g. F. bancrofti*; in some parts of the world the larvæ of this species are, however, non-periodic). The period under review has obviously been one of great activity in research on helminthes, and fertile in measures tending to reduce the risks of infection.

Insects, protozoa, and helminthes not only inflict direct injury on man; they also diminish his material welfare by impairing the health or causing the death of his horses, cattle, and sheep, by destroying food crops during growth, and, in the case of insects, by devouring the harvested grain. The measure of control which man can gain over insects, ticks, and

endoparasitic organisms, will determine largely the extent to which he can use and develop the natural resources of the rich tropical and sub-tropical zone of the earth.

Other applications of zoology to human well-being cannot be dealt with here, but mention should be made of two—the researches on sea-fisheries problems which have formed an important branch of the zoological work of Great Britain for forty years, and the studies on genetics which made possible an explanation of the mode of inheritance of a particular blood-group, and of some of the defects (*e.g.* colour-blindness and hæmophilia) and malformations which appear in the human race.

The Theory of the Affine Field.[1]

By Prof. ALBERT EINSTEIN, For. Mem. R.S.

THE theory of the connexion between gravitation and electromagnetism outlined below is founded on Eddington's idea, published during recent years, of basing "field physics" mathematically on the theory of the affine relation. We shall first briefly consider the entire development of ideas associated with the names Levi-Civita, Weyl, and Eddington.

The general theory of relativity rests formally on the geometry of Riemann, which bases all its conceptions on that of the interval ds between points indefinitely near together, in accordance with the formula[2]

$$ds^2 = g_{\mu\nu} dx_\mu dx_\nu \quad . \quad . \quad . \quad . \quad (1)$$

These magnitudes $g_{\mu\nu}$ determine the behaviour of measuring-rods and clocks with reference to the co-ordinate system, as well as the gravitational field. Thus far we are able to say that, from its foundations, the general theory of relativity explains the gravitational field. In contrast to this, the conceptual foundations of the theory have no relations with the electromagnetic field.

These facts suggest the following question. Is it not possible to generalise the mathematical foundations of the theory in such a way that we can derive from them not only the properties of the gravitational field, but also those of the electromagnetic field?

The possibility of a generalisation of the mathematical foundations resulted from the fact that Levi-Civita pointed out an element in the geometry of Riemann that could be made independent of this geometry, to wit, the "affine relation"; for according to Riemann's geometry every indefinitely small part of the manifold can be represented approximately by a Euclidean one. Thus in this elemental region there exists the idea of parallelism. If we subject a contravariant vector A^σ at the point x_ν to a parallel displacement to the indefinitely adjacent point $x_\nu + \delta x_\nu$, then the resulting vector $A^\sigma + \delta A^\sigma$ is determined by an expression of the form

$$\delta A^\sigma = -\Gamma^\sigma_{\mu\nu} A^\mu \delta x_\nu \quad . \quad . \quad . \quad . \quad (2)$$

The magnitudes Γ are symmetrical in the lower indices, and are expressed in accordance with Riemann geometry by the $g_{\mu\nu}$ and their first derivatives (Christoffel symbols of the second kind). We obtain these expressions by formulating the condition that the length of a contravariant vector formed in accordance with (1) does not change as a result of the parallel displacement.

Levi-Civita has shown that the Riemann tensor of curvature, which is fundamental for the theory of the gravitational field, can be obtained from a geometrical consideration based solely on the law of the affine relation given by (2) above. The manner in which the $\Gamma^\sigma_{\mu\nu}$ are expressible in terms of the $g_{\mu\nu}$ plays no part in this consideration. The behaviour in the case of differential operations of the absolute differential calculus is analogous.

These results naturally lead to a generalisation of Riemann's geometry. Instead of starting off from the metrical relation (1) and deriving from this the coefficients Γ of the affine relation characterised by (2), we proceed from a general affine relation of the type (2) without postulating (1). The search for the mathematical laws which shall correspond to the laws of Nature then resolves itself into the solution of the question: What are the formally most natural conditions that can be imposed upon an affine relation?

The first step in this direction was taken by H. Weyl. His theory is connected with the fact that light rays are simpler structures from the physical view-point than measuring-rods and clocks, and that only the ratios of the $g_{\mu\nu}$ are determined by the law of propagation of light. Accordingly he ascribes objective significance not to the magnitude ds in (1), *i.e.* to the length of a vector, but only to the ratio of the lengths of two vectors (thus also to the angles). Those affine relations are permissible in which the parallel displacement is angularly accurate. In this way a theory was arrived at, in which, along with the determinate (except for a factor) $g_{\mu\nu}$ other four magnitudes ϕ_ν occurred, which Weyl identified with electromagnetic potentials.

Eddington attacked the problem in a more radical manner. He proceeded from an affine relation of the type (2) and sought to characterise this without introducing into the basis of the theory anything derived from (1), *i.e.* from the metric. The metric was to appear as a deduction from the theory. The tensor

$$R_{\mu\nu} = -\frac{\partial \Gamma^\alpha_{\mu\nu}}{\partial x_\alpha} + \Gamma^\alpha_{\mu\beta}\Gamma^\beta_{\nu\alpha} + \frac{\partial \Gamma^\alpha_{\mu\alpha}}{\partial x_\nu} - \Gamma^\alpha_{\mu\nu}\Gamma^\beta_{\alpha\beta} \quad . \quad (3)$$

is symmetrical in the special case of Riemann's geometry. In the general case $R_{\mu\nu}$ is split up into a symmetrical and an "anti-symmetrical" part:

$$R_{\mu\nu} = \gamma_{\mu\nu} + \phi_{\mu\nu} \quad . \quad . \quad . \quad . \quad (4)$$

One is confronted with the possibility of identifying $\gamma_{\mu\nu}$ with the symmetrical tensor of the metrical or gravitational field, and $\phi_{\mu\nu}$ with the antisymmetrical tensor of the electromagnetic field. This was the course taken by Eddington. But his theory remained incomplete, because at first no course possessed of the advantages of simplicity and naturalness presented

[1] Translated by Dr. R. W. Lawson.
[2] In accordance with custom, the signs of summation are omitted.

itself, for the determination of the 40 unknown functions $\Gamma^{\alpha}_{\mu\nu}$. The following brief statement will serve to show how I have endeavoured to fill in this gap.[3]

If the German capital $\mathfrak{H}$ be a scalar density that depends only on the functions $\Gamma^{\alpha}_{\mu\nu}$, then Hamilton's principle

$$\delta\{\int\mathfrak{H}d\tau\}=0 \quad . \quad . \quad . \quad . \quad . \quad (5)$$

supplies us with 40 differential equations for the functions Γ, when we stipulate that during the variation the functions Γ are to be treated as magnitudes independent of each other. Further we assume that $\mathfrak{H}$ depends only on the magnitudes $\gamma_{\mu\nu}$ and $\phi_{\mu\nu}$, and thus write

$$\delta\mathfrak{H}=\mathfrak{g}^{\mu\nu}\delta\gamma_{\mu\nu}+\mathfrak{f}^{\mu\nu}\delta\phi_{\mu\nu} \quad . \quad . \quad . \quad (6)$$

where we have

$$\left.\begin{aligned}\frac{\partial\mathfrak{H}}{\partial\gamma_{\mu\nu}}&=\mathfrak{g}^{\mu\nu}\\ \frac{\partial\mathfrak{H}}{\partial\phi_{\mu\nu}}&=\mathfrak{f}^{\mu\nu}\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

At this point it should be noticed that in the theory developed here, the small German letters respectively represent the contravariant density ($\mathfrak{g}^{\mu\nu}$) of the metrical tensor, and the contravariant tensor density ($\mathfrak{f}^{\mu\nu}$) of the electromagnetic field. Thus in a well-known manner is given the transition from tensor densities (expressed by German letters) to contravariant and covariant tensors (expressed by the corresponding italic letters), and a metric is introduced which rests exclusively on the affine relation.

By performing the variation we obtain after some amount of calculation

$$\Gamma^{\alpha}_{\mu\nu}=\tfrac{1}{2}g^{\alpha\beta}\left(\frac{\partial g_{\mu\beta}}{\partial x_\nu}+\frac{\partial g_{\nu\beta}}{\partial x_\mu}-\frac{\partial g_{\mu\nu}}{\partial x_\beta}\right)-\tfrac{1}{2}g_{\mu\nu}i^{\alpha}+\tfrac{1}{6}\delta^{\alpha}_{\mu}i_{\nu}+\tfrac{1}{6}\delta^{\alpha}_{\nu}i_{\mu} \quad (8)$$

where

$$\frac{\partial\mathfrak{f}^{\mu\nu}}{\partial x_\nu}=\mathfrak{i}^{\mu} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Equation (8) shows that our extension of the theory, which appears to be so general, leads to a structure of the affine relation that does not deviate more strongly from that of the geometry of Riemann than is required by the actual structure of the physical field.

We now obtain the field equations in the following manner. From (3) and (4) we first derive the relations

$$\gamma_{\mu\nu}=-\frac{\partial\Gamma^{\alpha}_{\mu\nu}}{\partial x_\alpha}+\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha}+\tfrac{1}{2}\left(\frac{\partial\Gamma^{\alpha}_{\mu\alpha}}{\partial x_\nu}+\frac{\partial\Gamma^{\alpha}_{\nu\alpha}}{\partial x_\mu}\right)-\Gamma^{\alpha}_{\mu\nu}\Gamma^{\beta}_{\alpha\beta} \quad (10)$$

$$\phi_{\mu\nu}=\tfrac{1}{2}\left(\frac{\partial\Gamma^{\alpha}_{\mu\alpha}}{\partial x_\nu}-\frac{\partial\Gamma^{\alpha}_{\nu\alpha}}{\partial x_\mu}\right) \quad . \quad . \quad . \quad . \quad (11)$$

In these equations the $\Gamma^{\alpha}_{\mu\nu}$ on the right-hand side are to be expressed by means of (8) in terms of the $\mathfrak{g}^{\mu\nu}$ and $\mathfrak{f}^{\mu\nu}$. Moreover, if $\mathfrak{H}$ is known, then on the basis of (7) $\gamma_{\mu\nu}$ and $\phi_{\mu\nu}$, *i.e.* the left-hand sides of (10) and (11), can also be expressed in terms of $\mathfrak{g}^{\mu\nu}$ and $\mathfrak{f}^{\mu\nu}$. This latter calculation can be simplified by means of the following artifice. Equation (6) is equivalent to the statement that

$$\delta\mathfrak{H}^{*}=\gamma_{\mu\nu}\delta\mathfrak{g}^{\mu\nu}+\phi_{\mu\nu}\delta\mathfrak{f}^{\mu\nu} \quad . \quad . \quad . \quad (6a)$$

is also a complete differential, so that if $\mathfrak{H}^{*}$ is an unknown function of the $\mathfrak{g}^{\mu\nu}$ and $\mathfrak{f}^{\mu\nu}$, the following relations will hold:

$$\left.\begin{aligned}\gamma_{\mu\nu}&=\frac{\partial\mathfrak{H}^{*}}{\partial\mathfrak{g}^{\mu\nu}}\\ \phi_{\mu\nu}&=\frac{\partial\mathfrak{H}^{*}}{\partial\mathfrak{f}^{\mu\nu}}\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (7a)$$

We now have only to assume $\mathfrak{H}^{*}$. The simplest possibility is obviously

$$\mathfrak{H}^{*}=-\frac{\beta}{2}f_{\mu\nu}\mathfrak{f}^{\mu\nu} \quad . \quad . \quad . \quad . \quad (12)$$

In this connexion it is interesting that this function does not consist of several summation terms which are logically independent of each other, as was the case with the theories hitherto proposed.

In this way we arrive at the field equations

$$R_{\mu\nu}=-\kappa[(\tfrac{1}{4}g_{\mu\nu}f_{\sigma\tau}f^{\sigma\tau}-f_{\mu\sigma}f^{\sigma}_{\nu})+\gamma f_{\mu}f_{\nu}] \quad . \quad (13)$$

whereby $R_{\mu\nu}$ is the Riemann tensor of curvature. κ and γ are constants, f_μ is the electromagnetic potential, which is connected with the field strength by the relation

$$f_{\mu\nu}=\frac{\partial f_\mu}{\partial x_\nu}-\frac{\partial f_\nu}{\partial x_\mu} \quad . \quad . \quad . \quad . \quad . \quad (14)$$

and with the electrical current density by the relation

$$\mathfrak{i}^{\mu}=-\gamma\mathfrak{g}^{\mu\sigma}f_{\sigma} \quad . \quad . \quad . \quad . \quad . \quad (15)$$

In order that these equations may be in accord with experience, the constant γ must be practically indefinitely small, for otherwise no fields would be possible without noticeable electrical densities.

The theory supplies us, in a natural manner, with the hitherto known laws of the gravitational field and of the electromagnetic field, as well as with a connexion as regards their nature of the two kinds of field; but it brings us no enlightenment on the structure of electrons.

[3] Herr Droste of Leyden hit upon the same idea independently of the present writer.

Further Determinations of the Constitution of the Elements by the Method of Accelerated Anode Rays.[1]

By Dr. F. W. ASTON, F.R.S.

BY further use of the method of accelerated anode rays, results have been obtained with a number of elements since the publication of the isotopes of copper (NATURE, Aug. 4, p. 162). Details of the method will be published later. Most of the following results were obtained by the use of fluorine compounds of the elements investigated.

The mass-spectrum of strontium shows one line only, at 88. This was obtained in considerable intensity. If any other constituents exist they must be present

[1] A paper read on September 18 before Section A of the British Association Meeting at Liverpool.

in very small quantities, so that it is practically certain that the chemical atomic weight 87·63 at present in use is too low.

Cobalt also appears to be a simple element of mass-number 59, as was to be expected from its atomic weight, which has been determined with great care by a number of observers.

Scandium was successfully attacked by the use of material kindly supplied by Prof. Urbain, of Paris. The only line obtained was at 45. It may be taken provisionally to be a simple element, but the effects are not strong enough to disprove the presence of small quantities of another constituent.

Manganese behaved surprisingly well, and yielded unequivocal results indicating that it is a simple element of mass-number 55. This result is in good agreement with the chemical atomic weight, and is particularly interesting, for 55 is a term in the numerical series 2, 3, 5, 8, 13—all of which had previously corresponded to gaps in the list of weights of known species of atoms.

Gallium fluoride made from a specimen of the hydrate kindly provided by Prof. Richards, of Harvard University, also gave satisfactory results. Gallium consists of two isotopes, 69 and 71. The intensity relation between the lines agrees much better with the atomic weight 69·72 recently published by Richards than that previously in use, 70·1.

Vanadium and chromium give single mass-lines at positions expected from their atomic weights 51 and 52.

Titanium gives a strong line at 48. On one of the spectra obtained there is a faint and doubtful indication of a line at 50. Should this latter be confirmed it would tend to support Honigschmid's value 48·1 for the atomic weight rather than the lower figure 47·85 more recently obtained by Baxter.

Silver in the form of the chloride worked unexpectedly well, and gave two nearly equally intense lines at 107, 109.

Yttrium gives a single strong line at 89, another term of the numerical series already referred to, and completes the analysis of the first 39 elements.

A specimen of potassium hafnifluoride sent from Copenhagen by Dr. Hevesy was experimented with, but in no case were any lines visible in the region of the expected atomic weight of hafnium. This sample contained about 50 per cent. of zirconium, and an extremely faint effect at 90 shown here and on other plates taken with pure zirconium salts suggests this as the principal isotope of this element; but further work is necessary on this point.

Niobium, molybdenum, cadmium, barium, and lead have all been tried without any definite results, and it is feared that difficulties may arise in finding suitable compounds to use in the case of these and other elements not yet analysed. On the other hand, success with scandium and yttrium offers hope of obtaining the mass-spectra of all the rare-earth group.

The following is a list of the elements the composition of which has been first indicated by the use of accelerated anode rays. The mass-numbers were usually determined with reference to the lines of iron or iodine, and no outstanding divergence from the whole-number rule was observed.

Element.	Atomic Number.	Atomic Weight.	Minimum Number of Isotopes.	Mass-numbers in Order of Intensity.
Sc	21	45·1	1	45
Ti	22	48·1	1	48
V	23	51·0	1	51
Cr	24	52·0	1	52
Mn	25	54·93	1	55
Co	27	58·97	1	59
Cu	29	63·57	2	63, 65
Ga	31	69·72	2	69, 71
Ge	32	72·5	3	74, 72, 70
Sr	38	87·63	1	88
Y	39	88·9	1	89
Ag	47	107·88	2	107, 109

Obituary.

Sir Henry Hubert Hayden, F.R.S.

ALL who knew Sir Henry Hayden well enough must recall a passing thought, more than once definitely formulated, that some day his irrepressible keenness for exploring new and little-known lands would lead to accident. Those who had the inestimable privilege of knowing him with real intimacy know well that, if he had to choose a way of ending his career, it would be on a mountain side and in a fight against physical difficulties. He never revealed and probably never entertained but one fear—that the medical history of his family might repeat itself and render him unfit for further exploratory work. It is appropriate that he should be laid to rest near the foot of a great mountain, and appropriate too that it should be the mountain which he had just conquered, for as a mountaineer he was as efficient as he was daring.

To accomplish a difficult task in exploration was in itself his sufficient reward. Kindred spirits and but very few others knew of his accomplishments; for, without being reticent, he never looked to the "gallery": his photographs, maps, sketches, and collections were made readily available to specialists, but rarely, and only under pressure, were they turned into lantern slides. The end of one task was to him the beginning of the next: there never was an interval for popular demonstrations, and little even for rest.

Each geographical enterprise was invariably in a new field, and Hayden's geological work was just as varied — geotectonic problems in the Himalayas, economic mineral questions in various parts of India, pure palæontology, the application of geology to engineering problems, and the microscopic petrology of igneous rocks formed the subjects of his papers, each treated in turn with a thoroughness and sense of relativity that revealed a wide and precise acquaintance with literature, which was always surprising to those who were impressed by his restless physical activity in the field.

Since January 3, 1895, when I met Hayden on his landing at Calcutta to join the Geological Survey of India, I have been in closer and perhaps more constant touch with him than most of his friends, and during those twenty-eight years I never heard from him an ungenerous remark about a colleague, never heard him grumble about the climate, at the work, or even at the inequalities of treatment that seem to be the

inevitable characteristic of every form of official service. Two examples are worth recording, for every friend of Hayden will recognise them as typical.

We were moving camp to a new field where there was a probability that the fast-coming hot weather would soon make work difficult. The hot, west winds, laden with fine dust, had significantly started as a warning that life in tents would soon be impossible. Every day was important, when, through the negligence of a local subordinate official, transport facilities broke down absolutely within twenty miles of our new field. I was annoyed especially because my mail having been directed from headquarters to the new camp, the enforced halt could not be utilised even for office work. There seemed to be no escape from a wasted day of useless grumbling. On rising next morning Hayden was missing, but by noon he turned up loaded with heavy postal packets, and then I found that he had been to fetch my mail, and, as I afterwards discovered, had cycled nearly forty miles over what only an Indian District Board would be content to call a road. Few but Hayden would have thought of it; none but Hayden would have done it silently, as if it were only the usual thing.

Four years later Sir Francis Younghusband was starting on his mission to Lhassa. The remarks in the Director's Annual Report for 1902–3 (Rec. Geol. Surv. Ind., vol. xxxii. pp. 153-156) show why at that time we were anxious to know whether on the northern side of the snow-covered, crystalline range of the Eastern Himalaya there had been an extension of the Mesozoic fossiliferous basin which had been surveyed in Spiti and other parts of the north-western Himalaya. I hurried to Darjeeling to intercept Younghusband, who was then on his way to join the expedition that had already started into Sikkim. He realised the value of the problem and readily offered to give facilities for a geologist to join the party, but warned me that unless an officer could move at once he might be too late. I returned immediately to Calcutta and put the question before Hayden, who promptly volunteered to cancel his local engagements, and although he knew the meaning of winter on the inhospitable plateau of Tibet, did not wait to discuss conditions or settle his local affairs, but moved off within twenty-four hours, trusting to pick up transport and equipment on the way. Within a fortnight there came back a parcel of Spiti shale fossils and a letter that opened a new chapter in Himalayan geology. Hayden was away for more than a year, and how he covered so much ground with such excellent results was known only to him and to his kindred spirit, Sir Francis Younghusband.

Always moving rapidly, but never too hurried to help a colleague; always doing something, but mentally as well as physically, Hayden piled up a record of solid results which would have been the envy in turn of the sportsman, the explorer, the scientific worker and the most orthodox official. After graduating at Trinity College, Dublin, in engineering as well as arts, he made a journey round the world before joining the Geological Survey of India in 1895. He was appointed Director of the Department in 1910 and held office for eleven years. Meanwhile, as a junior officer his work touched most of the provinces of India, but his Himalayan and trans-frontier stratigraphical work naturally attracted most attention, the chief scientific results being included in his memoirs on Spiti and Bashahr (Mem. Geol. Surv. Ind., vol. xxxvi., part 1), on the provinces of Tsang and Ü in Central Tibet (vol. xxxvi., part 2), and on Northern Afghanistan (vol. xxxix., part 1). Just before leaving for Switzerland he completed and sent to the press in French his account of the journey through northern Tibet during 1922, that is, after he had retired from the Indian Government service.

In 1915 the Geological Society awarded Hayden the Bigsby medal, and he was elected a fellow of the Royal Society in the same year, whilst Calcutta University conferred on him the honorary degree of D.Sc. He served successively as president of the Mining and Geological Institute of India and of the Asiatic Society of Bengal. In 1911 his official service was recognised by the C.I.E.; in 1919 he received the senior order of C.S.I., and on the day of his embarkation at Bombay in June 1920, preparatory to retirement from the office of Director of the Geological Survey, his knighthood was gazetted.

The accident which led to Hayden's death with his two guides must have occurred soon after August 12, on his return from an ascent of the Finsteraarhorn, but his body was not found until August 28. The details of his death will never be known, but if the final and determining incident was not a definite attempt to save his companions, it was not Hayden's fault. He was buried by friends on September 1 at Lauterbrunnen, and the selection of the spot would almost certainly be in accordance with his own wish. Perhaps of all the many incidents that one can recall as illustrations of his generous nature, my last glimpse of him was the most characteristic: it was just a few days before he started on his tour in Switzerland; he was busy with his preparations, but looked in to say farewell on his way to see the sick relative of a friend who was away from home. One frequently came across instances of his generosity to the poor and sick, but not even the most intimate of his friends knew them all; as in his work, each act of kindness followed too closely on its predecessor to allow of time for talking about it.

T. H. HOLLAND.

THE issue of the *Physikalische Zeitschrift* for July 15 contains an obituary notice of Prof. O. Lehmann by Drs. A. Schleiermacher and K. Schachenmeier. He was born on January 13, 1855, at Constance, where his father, F. X. Lehmann, was director of the training college. As an only child he spent much time in his father's laboratory and was interested in his search for mathematical law in organic life. He studied under Kundt and Groth at Strasbourg, and after graduating taught in schools in Baden and Alsace until 1883, when he became lecturer and afterwards extra professor at the polytechnic at Aix-la-Chapelle. After a year as extra professor at Dresden he succeeded Hertz as director of the physics department of the technical school at Carlsruhe in 1889. He took a prominent part in the meetings of the scientific society of Carlsruhe and was noted for the experiments with which he illustrated his lectures. He is best known in Great Britain for his work on liquid crystals and for the improvements he made to the microscope to facilitate that work. His death occurred on June 17, 1922, some time after his retirement.

Current Topics and Events.

THE ninety-first annual meeting of the British Association, which closed at Liverpool on Wednesday, September 19, was one of the most successful in the history of the Association, and all who have been concerned in the arrangements for it, whether local or sectional, are to be congratulated upon the gratifying result of their work. More than three thousand members attended the meeting, and the facilities afforded them for social amenities and scientific discussion were much appreciated by all. As nominated by the Council, Sir David Bruce was elected by the General Committee as president for the meeting to be held in Toronto on September 3-10 of next year. The Committee also cordially accepted the invitation from Southampton to meet there in 1925. On Monday, September 17, the honorary degree of doctor of science of the University of Liverpool was conferred upon the following distinguished men of science: Sir Ernest Rutherford; Prof. Niels Bohr, professor of physics in the University of Copenhagen; Dr. E. H. Griffiths; Prof. G. N. Lewis, professor of chemistry, University of California; Prof. G. Elliot Smith, professor of anatomy in University College, London; Dr. Johs. Schmidt, director of the Carlsberg Laboratory, Copenhagen; and Prof. J. C. McLennan, professor of physics in the University of Toronto.

CANON BARNES of Westminster preached the sermon on Sunday last in the Lady Chapel of Liverpool Cathedral on the occasion of the British Association's visit to that city. He dealt with "The Influence of Science on Christianity," and with characteristic courage attributed the waning influence of the churches to the obscurantism and static outlook of many exponents of religion. Christianity has gained much from progress external to itself; the pronounced ethical progress in the Roman Empire in the second century was a wide movement for which religion cannot claim the whole credit; thirteen centuries later the Renaissance had an invigorating effect, producing in the churches changes destined to be as permanent and valuable as they were extensive: the pity was that in the nineteenth century the churches did not take advantage of the changes produced in the outlook of educated men by the scientific movement, but, led by the tractarians, adopted rather an attitude of hostility which has resulted in the modern conflict of ideas among clerics themselves, and has prejudiced educated people against their teachings. "Faith is a necessity of existence. Zealots still contend that there is a moral value in blind faith. But the modern world, so far as it has fallen under the sway of the scientific method, demands that faith shall be reasonable and not blind." Inability to grasp new ideas, reluctance to discard or even to modify theories or beliefs, are qualities perhaps more rare among scientific workers than among theologians; but we are too accustomed to the conservatism of outlook among the former, particularly those whose life-work has been in the direction of elaboration of what are to them fundamental principles amounting to beliefs, to fail to appreciate the magnitude and importance of the task of the best contemporary theologians in combating religious obscurantism.

IF the first accounts exaggerated the number of lives lost, the latest figures reveal the completeness of the disaster caused in Japan by the earthquake of September 1. Although the exact number of deaths caused by earthquake and fire is still unknown, it is estimated that, approximately, 110,000 were killed in Tokyo, 30,000 in Yokohama, 10,000 in Kamakura, 10,000 in the Miura Peninsula, 700 in Odowara and Atami, and 5000 in the Boso Peninsula—a total of 165,700. In Yokohama, about 71,000 houses were destroyed and about 100 escaped damage; in Yokosuka, all but 150 out of 11,800 houses were destroyed; in Tokyo, 93 per cent. of the houses were burnt or crushed. Most of the high concrete buildings damaged in Tokyo show fissures in the third-floor façades, but above and below that floor there is little injury. The fire destroyed a great part of the Imperial University, including 700,000 volumes in the library. At first, the shock at Yokohama was not severe and differed little from those so often felt in Japan. Then, suddenly, there came a swirling motion (the vorticose shock of the Italians), during which practically all houses collapsed instantaneously. Several early reports with regard to the effects of the shock prove to have been erroneous. There was no volcanic eruption in the island of Oshima and none of the islands off the Izu Peninsula disappeared. Dr. Nakamura has made a preliminary investigation of the central area. He finds that the earthquake originated in two separate foci, one between Oshima and Atami, in which the first and more violent movement seems to have originated, the other near the naval station of Yokosuka.

THE Howard silver medal for 1923 of the Royal Meteorological Society has been awarded to Cadet J. C. Needham of H.M.S. *Worcester* for the best essay on "Tropical Storms." The medal was competed for by the cadets from H.M.S. *Worcester*, H.M.S. *Conway*, and the Nautical College, Pangbourne.

THE International Commission of Eugenics met at Lund in Sweden on September 1 and 3 under the chairmanship of Major Leonard Darwin. Various resolutions were passed, and the question where the next international congress should be held was discussed. Profs. Nilsson-Ehle and Johansson were appointed members of the Commission. The Commission was entertained at dinner by the Mendelian Society and visited the Swedish Institute of Genetics at Akarp near Lund, and the Swedish State institute for race biological investigation. These are the only institutions in the world for genetics or eugenics which are State-endowed.

"HEALTH WEEK" is to be celebrated on October 7–13. This movement was instituted in 1912 and the arrangements are made by a committee appointed by the Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.1. The object of Health Week

is to focus public attention for one week in the year on matters of health, and to arouse that personal responsibility for health, without which all public work, whether by Government or by Local Authorities, must fall far short of its aims. It is suggested that the dominant idea should be "Self Help in Health," and the consideration of what every individual can do for himself and his neighbour in securing a healthy life. While there is this central Health Week Committee, local celebrations in each centre are organised and controlled by local committees, and a circular has been issued for the formation and guidance of the latter, containing suggestions for the programme of events and subjects for lectures. The Health Week Committee is working in cordial co-operation with the National Baby Week Council (already referred to in these columns), and it has been found convenient in several instances to combine the celebrations of Health Week and Baby Week.

An Empire Mining and Metallurgical Congress is to be held at the British Empire Exhibition in London during the first week in June 1924. The Institution of Mining and Metallurgy, the Institution of Mining Engineers, the Institution of Petroleum Technologists, the Iron and Steel Institute and the Institute of Metals, representing the scientific and technical interests of the mineral and metal industries, with the Mining Association of Great Britain and the National Federation of Iron and Steel Manufacturers, are co-operating as conveners of the Congress. This is the first such Congress to be held, and it is anticipated that succeeding sessions will be held in the Dominions under the auspices of an Empire Council of Mining and Metallurgical Engineering Institutions, which it is hoped will be constituted as a result of the inaugural Congress. Viscount Long of Wraxall will deliver the Sir Julius Wernher Memorial Lecture of the Institution of Mining and Metallurgy at the opening session of the Congress, taking mineral resources and their relation to the prosperity and development of the Empire as his subject. The May Lecture of the Institute of Metals to be delivered by Dr. F. W. Aston, on "Atoms and Isotopes," will also form part of the programme of the Congress.

An unusual insurance claim is recorded by the New York correspondent of the *Times* in a message dated September 13. The University of Indiana took out a policy at a cost of about 30*l.* to insure against possible failure of the party from the University sent to Ensenada, Mexico, to take good photographs of the total solar eclipse of September 10. The expedition was unsuccessful, and the insurance company duly paid out about 300*l.*, which is to go towards the cost of the expedition. A similar insurance policy, but for 2000*l.*, was taken out by the Swarthmore College party, which was also in Mexico. The compensation in this case was to be inversely as the success of the expedition in obtaining photographs. It is stated that good photographs of the solar corona were obtained.

Up to July 2, no less than 826 broadcasting stations had been licensed in the United States. For various reasons, however, chiefly financial, 376 of them have ceased to operate. Nearly half the total number of working stations are run by radio and electrical companies. The rest are run by newspapers, stores, colleges, churches, etc. That the art of broadcasting has come to stay is proved by the fact that only a small percentage of the stations were discontinued because their service was unsatisfactory to the public. In a few cases stations were closed down because of the competition of neighbouring rival stations. In Great Britain there is only a single organisation for broadcasting, and so the public does not get the benefit of improved service owing to competition. On the other hand, however, it is imperative that the industry be in a sound financial position if it is to work satisfactorily.

A memorandum on the rainfall in India during June and July and the probable amount during August and September has recently been issued by the Indian Meteorological Department. The monsoon was late in arriving on the shores of India, and was weak throughout the month of June. There was a general strengthening of the monsoon currents in the early part of July, and during the month well-distributed rain fell over most of India. For the two months of June and July the rainfall over the plains of India was about 6 per cent. above normal. The excess was large in Lower Burma and in the North-West Frontier Province and Rajputana West. The amount was short of the normal by more than 20 per cent. in most of the Madras Presidency, Orissa, the East Central Provinces, Berar, the West United Provinces, and mostly along the western frontier. The forecast issued in the early part of August states that there is no reason to expect any large departure from the normal in the rainfall of India generally in August and September. Reports received from India by the India Office show for the mid-week in September that there was an excess of rain in west Central India, north Hyderabad, and south-east Madras; normal amounts in Lower Burma, Orissa, west Central Provinces, and north Madras; elsewhere rains were scanty.

Prof. A. R. Forsyth recently delivered a lecture on the life and work of Sir Isaac Newton, under the auspices of the London County Council, and it is published as an article in the *Empire Review* for September. This is an opportune moment to refresh the public memory on Newton's life and achievement, when so much interest is being taken in Einstein's modification of the Newtonian law of gravitation. In addition to a biographical sketch, the article gives a summary of the state of mathematics and astronomy when Newton was at Cambridge, and the preparatory work done by Copernicus, Tycho Brahé, Kepler, and Galileo in leading up to the Principia. It is explained that the geometrical methods of the Principia were adopted, because the validity of the infinitesimal method, which Newton had himself employed, was still a matter of controversy. Comment is made on the curious fact that Newton took a degree of the earth's circumference as 60 miles in his first abortive

test of his law; the correct value had been published in England thirty years earlier by Richard Norwood. The fact that international jealousy delayed the universal acceptance of the law of gravitation seems strange to us now; there is, however, a slight echo of it in the antipathy shown to Einstein in some quarters, because of his nationality. The article shows the important part that Voltaire played in persuading the French of the truth of Newton's law. Thus we find that before the return of Halley's comet in 1759, Clairaut and Lalande calculated its perturbations by gravitational methods. Prof. Forsyth makes the practical suggestion that the bicentenary of Newton's death in 1927 should be marked by a new edition of his collected works. There has been none since Horsley's edition in 1785, and many additional manuscripts have been discovered since that date.

THE Almanac for the year 1923 published by the Egyptian Government contains, in addition to the usual statistical information, a good deal of matter of scientific interest. There are chapters on the geographical features, and special attention is given to the Nile. Agriculture and antiquities receive considerable attention, and there is a long section on irrigation. It is noted that the almanac is intended to be explanatory and descriptive rather than statistical, and in this respect is intended to supplement the "Annuaire Statistique." The book is a valuable volume of reference on Egypt.

Our Astronomical Column.

A LARGE FIREBALL.—Mr. W. F. Denning writes: "On September 7, at 7.45 P.M., G.M.T., a large fireball was observed from many places in the south-west of England. As viewed from Par, Cornwall, it appeared as large as the full moon, and passed from the west over north-west, and finally disappeared in north-north-west. It left a brilliant trail of light, and this remained conspicuously obvious to the unaided eye during five minutes. The trail exhibited some singular changes of shape and position while it continued in sight. It first assumed a vertical direction, after which the extremities curved to the left and formed a semi-circle.

"A number of other observers in Cornwall have reported observations of the phenomenon, and among other places it appears to have been well observed at Fowey, Liskeard, and Polruan. The object was also seen from Southampton, from which place the enduring streak was situated due west at an altitude of 16°."

STELLAR MASSES.—Accumulating statistics on binary systems, combined with the great increase in the number of fairly trustworthy parallaxes, have made it possible to deduce mean values of the stellar masses for each spectral type. Messrs. Russell, Adams, and Joy investigate the matter in a joint paper in Pub. Ast. Soc. Pacific for August, using about 400 stars. They assign to type O masses of 6 to 9, to type B mass 6, to giants of types A to G masses 2 to 4, and to the dwarfs of all classes masses ½ to 2½; in each case the unit is the sun's mass.

On plotting mass against absolute magnitude, they obtain a graph that is practically a straight line, though with a slight upward bend for type B. This result seems to lead to a fairly obvious corollary, which is not, however, given by the authors. It is that the duration of the stellar universe in the past is of the same order as that of the luminous period of individual stars. If it were much greater than this, then even the most massive stars would have had time to distribute themselves among all the ranks of absolute magnitude. The same conclusion is obtained by dynamical studies of the stellar motions, which do not indicate any great preponderance of non-luminous stars.

The recently published report of the Cape Observatory states that the stellar masses are also being investigated there. The results suggest that the masses group themselves about certain standard values, 11½, 5¾, 2⅞, 1¼ of the sun, each being about double the following. If this law should be established, it would indicate that the large masses were determined by some physical cause, and that they were liable to successive subdivision into equal parts.

HEAT RADIATIONS OF PLANETS.—Allusion has already been made in these notes to the investigation by Messrs. Edison Pettit and Seth Nicholson on the dark heat-waves emitted by the planets. These are isolated by the use of a cover-glass transmitting between 0·3 μ and 5·5 μ (with a weak extension to 7·5 μ), and a water-cell transmitting between 0·3 μ and 1·3 μ. The curve of atmospheric transmission at Mt. Wilson is a very complicated one, with eight minima between 0 and 8 μ, and two maxima between 8 μ and 14 μ. The dark planetary radiations are chiefly in the latter region. The deflexion from the planet Mercury has been compared with that from the moon, the ratio of radiation per unit area being 264/206, a smaller ratio than would be expected in view of Mercury's proximity to the sun. The authors make the suggestion that it may indicate a rapid rotation of Mercury; they note in corroboration of this that they obtain a sensible deflexion even from the dark portion of Mercury's disc.

Their former measures indicated practically no dark heat from Jupiter, but the present series gives 78·1 per cent. of its radiation between 0·3 μ and 1·3 μ, 15·3 per cent. between 1·3 μ and 5·5 μ, and 6·6 per cent. between 8 μ and 14 μ.

A SMALL STELLAR MASS.—*Astr. Nachr.*, No. 5246, contains an investigation of the orbit of the binary O. Struve 400, by P. Meier. The position for 1900 is R.A. $20^h\ 6^m\ 54^s$, N. Decl. 43° 39′, magnitude 7·7, spectral type G 3; trigonometrical parallax 0·043″ (Sproul Observatory), spectroscopic parallax 0·030″ (Mt. Wilson). The elements obtained are: period 84·4 years, periastron 1885·1, e 0·48, ω 19·4°, Ω 143·9°, i 62·5°, a 0·428″. The observations used extend from 1843 to 1922, so that practically a revolution has been completed. Using the Sproul parallax, the sum of the masses is 0·138 of the sun. (By a slip this is printed in *Astr. Nachr.* as 0·014 of the sun.)

The smallest stellar mass hitherto measured is that of the faint component of Krüger 60, which is about one-seventh of the sun; but if the present result is trustworthy, the joint mass of the pair is equal to that of this star.

A comparison of observed and computed positions is given. The agreement is fair, considering the closeness of the pair. The star is one that should be kept under observation. The components are furthest apart, 0·62″, in 1932; the separation is more than 0·50″ till 1948.

Research Items.

The Horse in Babylonia.—In the June issue of the Philadelphia *Museum Journal* Mr. Leon Legrain describes a series of Babylonian seals in the museum collection. In one of the most remarkable the rider, whip in hand, is represented with a bird-like head in profile with no distinct hair or beard, mounted on an animal which may be a horse or a donkey. Mr. Legrain is half disposed to regard this as the first representation of the horse in Babylonia, but this is far from certain. In the only known example of this type the animal has been called a bull, and the rider identified with the thunder god, Ramman Adad. But as the seal probably dates from the time of the Guti invasion, this mode of riding astride may be a new and foreign feature imported from the north-east by the Guti people.

Effect of Drying upon the Skull.—In an interesting paper in the *Journal of Anatomy* (vol. lvii., pt. iv., July 1923), T. Wingate Todd discusses the effect of maceration and drying upon the linear dimensions of the green human skull. His observations cover the effects of drying upon twenty-four macerated skulls and the differences between eight green skulls and the same within twelve hours of emergence from the macerator. He concludes that great individual variation occurs in percentage shrinkage, which, relatively small for length, increases somewhat for breadth and height, upon transformation from the green to the dry macerated state. The average shrinkage (all dimensions) amounts to about 1·1 per cent. of the final measurement. The duration of measurable shrinkage is about three weeks; but shrinkage demonstrable by shifting of the Euryon may continue for three months. Sex, stock, age, cranial thickness, cranial shape, and the condition of sutures are all eliminated as factors having no influence upon shrinkage. In passing through the stage of maceration, and during the first few hours of drying, the green skull loses a total average of 0·84 mm. in length, breadth, and auricular height. The average total shrinkage in complete transformation from the green to the dry macerated state is given as 5·6 mm., corresponding to a reduction of about 42 c.c. in a cranium of some 1500 c.c. capacity. The writer further gives examples showing that, given the linear dimensions in green and dry macerated states, it is possible to calculate the shrinkage in capacity to within a few cubic centimetres by either the Cleveland formula or those of Lee and Pearson.

Bird Censuses in the United States.—The United States Department of Agriculture has just published, as Bulletin No. 1165, a "Report on Bird Censuses in the United States: 1916 to 1920," by May Thatcher Cooke, of the Bureau of Biological Survey. The paper deals with an interesting attempt to establish a statistical basis for the study of the problems of bird population—the numbers and distribution of birds of different species, annual and other fluctuations, and the effects of irrigation, of cultivation, of the clearing of woodlands, and of protective legislation. The subject is one both of scientific interest and of economic importance: the study of it is not unknown in Great Britain, but it has not so far been undertaken on an important scale. A census takes the form of an annual count of the number of breeding pairs on a defined tract of land which is taken to be representative of the district as a whole. The conclusions so far reached in America, as mentioned in the paper under notice, are purely tentative, and only a part of the United States is adequately covered by the records for the period. For the section of the country lying north of Maryland and the Ohio River and east of the Great Plains, a little more than one pair of birds to the acre is found to be the present average for farm land. For the land immediately surrounding the farm buildings, and including lawns and orchard, the average is about 130 pairs per 100 acres, the estimated population of an entire farm of 100 acres being about 112 pairs. The American robin (*Turdus migratorius*) is the most abundant species in those States lying north of North Carolina and east of the Mississippi, and the alien house-sparrow (*Passer domesticus*) takes second place: for farm land in this section there are about 9 pairs of robins and 8 pairs of sparrows per 100 acres. Further and more comprehensive figures should make interesting comparisons possible.

The Opalinid Ciliate Infusorians.—Dr. M. M. Metcalf has recently published (U.S. Nat. Mus., Bull. 120) what he describes as a preliminary review—a memoir of 484 pp., with 258 illustrations—of these ciliates which live in the rudimentary cæcal portion of the rectum of Anurid amphibia. Most of the material used in the study of the 150 new species, sub-species, and formæ was obtained from museum specimens of Anura which had lain long—some for more than eighty years—in alcohol. The author gives a general account of the structure and life-history of *Protoopalina intestinalis*—a binucleate opalinid—and deals in some detail with mitosis and other nuclear phenomena in this and other forms. He concludes that each ordinary nucleus of an opalinid contains both trophic and reproductive chromatin in full activity. Dr. Metcalf discusses the relationships (*a*) of the four genera—Protoopalina, Zelleriella, Cepedea, and Opalina, and (*b*) of the family. He suggests that the Opalinidæ and Trichonympha may have arisen from similar ancestors, and that still more probably the Euciliata arose from ancestors which had become disturbed in their relations of mitosis and fission, and that they had passed through a pseudobinucleate condition to one of true binucleation, finally reaching their present structure, having two nuclei—one hypertrophied for metabolism, the other inactive except during the sexual period. An important section of the memoir deals with the geographical distribution of the species of Opalinidæ and the families and sub-families of the Anura.

Skin Spot of Potatoes.—Skin spot has frequently been regarded as a relatively unimportant blemish upon the potato tuber, so that considerable interest was aroused by the recent announcement by Shapovalov (*Journ. of Agricultural Research*, vol. 23, pp. 285-294) that the pustules of this disease represent a primary stage of corky scab, a much more serious trouble produced by *Spongospora subterranea*. Until this paper, it had been generally assumed on the basis of a paper by Miss M. N. Owen (*Kew Bulletin*, 1919, pp. 289-301) that skin spot was due to quite a different organism, a new species of Oospora, named by the discoverer *O. pustulans* Owen and Wakef. As skin spot frequently occurs upon seed tubers of many of the best-known varieties of potatoes, it was obviously of great importance to know whether the organism causing skin spot could also give rise to corky scab, and potato-growers will read with relief the communication by W. A. Millard and Sydney Burr in *Kew Bulletin*, No. 8 for 1923. This work

records the results of inoculation experiments with both *Oospora pustulans* and *Spongospora subterranea*, which confirm Owen's original conclusions completely, and leave no doubt that the first organism is responsible for skin spot and the second for corky scab. Anatomical investigations of the pustules also show clear differences between those of skin spot and of corky scab, and there is no likelihood of a skin spot pustule later masquerading as a typical corky scab. Shapovalov's contrary results were obtained in the United States, and Millard and Burr are therefore led to make the suggestion, inevitably suggested by their own work, that except when the American author examined diseased tubers sent from Europe, he never had typical skin spot under observation.

VARIATIONS IN LEVEL OF LAKE VICTORIA NYANZA.—Attention was directed in 1904 to the remarkable variations in the level of the Victoria Nyanza by Col. Lyons, who attributed some of them to differential movements in the adjacent land. The general oscillation of the level in that lake and in the Albert Nyanza is described by Mr. C. E. P. Brooks in a Geophysical Memoir, No. 20, issued by the Meteorological Office (1923; 8 pp., 1 pl.; price, 1*s.* 6*d.*). Mr. Brooks describes the variations in the lake levels as recorded by tide gauges on the Victoria Nyanza from 1896 to 1922 and on the Albert Nyanza from 1904 to 1922, and compares the rise and fall of the lakes with the variations in sunspots and rainfall. The discharge from the Victoria Nyanza over the Ripon Falls is estimated at only 6 per cent. of the rainfall on the basin of the lake. Most of the rain is removed from the basin by evaporation, which Mr. Brooks regards as highest during periods of sunspot minima, so that the lake level is then normally lowest. He claims that the lake levels accord more closely with variations of sunspots than with those of rainfall. He points out in illustration of this view that the great rise in the level of the two lakes in 1917 was "entirely unconnected with any increase in the rainfall." The curves on the plate illustrating the memoir show a general agreement of the sunspot minima with the lake levels: but the agreement is not complete, for the sudden rise in 1901 followed an increase in rainfall but without any equivalent movement in the sunspot curve. There was a similar disagreement in 1913, and moreover, the high level of the Victoria Nyanza in 1906 preceded instead of followed the sunspot maximum of 1907.

SPACE FORMULÆ OF BENZENE, NAPHTHALENE, AND ANTHRACENE.—The carbon atoms of the benzene molecule are shown by B. Orelkin (Jour. Russ. Phys.-Chem. Soc., 1923, 54, pp. 493-532) to be situated at the corners of a regular octahedron. This conclusion is arrived at from geometrical considerations, which show that the above arrangement of the carbon atoms is the only one in which the thirty valency electrons of the benzene molecule can form a stable system. In support of this formula it is claimed that it explains why more or less than six carbon atoms cannot form an aromatic nucleus. The properties of the aromatic nucleus are explained as due to the peculiar arrangement of valency electrons around the carbon atoms, whereby each of the latter possesses two electrons in common with its neighbours. Sachs found that the relative distances of the *o*-, *m*-, and *p*- positions were as $1 : \sqrt{2} : \sqrt{3}$, and the same proportion is shown to hold for the formula now deduced. The space formulæ of naphthalene, anthracene, and chrysene are obtained by the condensation of two, three, and four benzene nuclei, and the angles of the space lattices of crystals of these substances are calculated from their molecular structure. These calculated values agree very closely with experimental values obtained by other workers.

LOW-TEMPERATURE CARBONISATION OF COAL.—The Fuel Research Board of the Department of Scientific and Industrial Research has just issued a Technical Paper No. 7 on "Preliminary Experiments in the Low-temperature Carbonisation of Coal in Vertical Retorts" (H.M. Stationery Office, 10*d.* post free). The paper may usefully be read in continuation of the report of the same body for the years 1920 and 1921, analysing the technical and economic problems to be faced in establishing a British industry of low-temperature carbonisation. The necessity for low operating costs, therein emphasised, implies a minimum of manual labour, and the use of the continuous vertical retort is one way of attaining this. An installation of such retorts on the Glover-West system now exists at the Fuel Research Station, Greenwich. Though designed for working under the high temperature conditions now current in towns' gas works, they have been employed in carbonisation trials, now reported, in which low working temperatures were maintained. The setting is ill adapted for securing the best results under such conditions, but the tests—admittedly of an exploratory character—have been carried out to obtain information likely to assist in the design of more suitable retorts. Such retorts have been constructed and trials are to be carried out in them. In the present tests flue temperatures ranged from 700° to 850° C., and it was found advantageous to inject steam into the retort, both to cool the coke and to assist in distributing heat through the charge. A coke was obtained containing about 7 per cent. of volatile matter and said to be suitable for use in domestic grates. The high proportion of breeze in the coke suggests trouble and loss in transportation. Per ton of coal, there was obtained a yield of 12-16 gallons of tar having a "low temperature" character and 18-28 lb. of ammonium sulphate. The yield of gas was only 45-50 therms per ton—very low from the gas-maker's point of view and fatal to commercial success unless the coke realised a very high price. As no finality is claimed for these results, the results from the new retorts will be awaited with interest.

HEAT LOSSES THROUGH HOUSE WALLS.—The Building Research Board of the Research Department has issued, as Special Report No. 7, accounts of the tests carried out at the National Physical Laboratory of the heat transmitted through walls of various types when one surface is hotter than the other, of those made in Norway on the heat insulating properties of the walls of experimental huts constructed in more than 20 different ways in use in that country, and of similar tests carried out in Sweden and in Germany. So far as the British tests have been conducted, they show that a solid gravel concrete wall and a wall of sand-lime bricks transmit about the same amount of heat under the same conditions, but that a wall of stock bricks only transmits about $\frac{3}{4}$ as much heat. A cavity wall of ordinary type transmits about $\frac{1}{2}$ to $\frac{2}{3}$ that of a solid wall according to the size of the cavity. The Norwegian results include the cost of construction and show in a remarkable way the low heat transmission through the less costly wooden walls of various types common in that country. Where cavity walls are used the best arrangement is to place the thicker portion in the interior. The Swedish results, so far as they go, confirm the above conclusions. The German results have led to a subdivision of the air cavity between thin concrete walls into six or more layers by means of paste-boards.

Scientific Exhibition at British Association Meeting.

THE ninety-first annual meeting of the British Association, which has just drawn to a close at Liverpool, was characterised by a new and important departure in the form of an exhibition of scientific apparatus, instruments, and diagrams. The exhibition was on the lines of that organised each year in London by the Physical and Optical Societies, which is so effective in bringing together the users and makers of physical apparatus, but its scope was naturally wider, and many branches of pure and applied science were represented.

In opening the exhibition on Monday, September 10, Sir Charles Sherrington commented upon the comprehensive and representative character of the exhibits, remarking that it was very appropriate that such a collection should be brought together, and that this—the first of its kind—constituted a definite development in the history of the British Association. He further referred to the remarkable advances in the making of scientific instruments during the last three hundred years, to the ever-growing importance of instrumentation, and to the unavoidable complexity of the apparatus needed for some of the simplest and therefore the most fundamental of scientific inquiries.

Admission to the exhibition was not confined to members of the British Association, to whom it was free, but the doors were opened to any member of the public on payment of the moderate sum of one shilling for one day only, while three times that amount guaranteed admission at any time during the fortnight of the exhibition. The results for the first week show that this arrangement was happily inspired, and that the exhibition was as popular with the outside public as with members of the Association. The number of daily tickets sold was quite naturally largely in excess of the number of season tickets, but the demand for the latter was quite sufficient to justify their issue.

The exhibition committee was fortunate indeed in having at its disposal the excellent accommodation afforded by the Central Technical Schools, Byrom Street, and the exhibits occupied the rooms on three floors of this magnificent building. The fine lecture hall enabled daily lectures, in some cases illustrated by cinematograph films or experiments, to be given by men of science, a feature which contributed in no small degree to the success of the exhibition. The popularity of these lectures is sufficiently illustrated by the fact that arrangements were made for two at least to be delivered a second time—"The Optophone," by Prof. Barr, and "Researches in Special Steels," by Mr. S. A. Main (Research Department of Sir Robert Hadfield's, Ltd.). Other lectures included "Ripples," by Prof. L. R. Wilberforce; "Research and Industry," by Sir Frank Heath; "Experiments on Coal Dust Explosions in Mines," by Prof. H. B. Dixon; "The Compass in Navigation," by Capt. Creagh-Osborne, R.N.; "Flame," by Prof. A. Smithells; "Kodachrome Cinematograph," by Dr. Mees (Kodak Co., London); "Developments in Wireless Telegraphy," by Commander Slee (Marconi Co., London).

Much attention was attracted by demonstrations, daily throughout the meeting, of the photophone exhibited by Prof. A. O. Rankine, and the optophone (Barr and Stroud, Ltd.). In the former, the transmitter or light modulator was installed in a room in St. George's Hall, and the beam of light, fluctuating in sympathy with the vibrations constituting the sounds to be transmitted, was thrown across the intervening space of some two hundred yards to the room in the Central Technical Schools where the receiving apparatus was located. The fluctuating light here controlled the electric current in a selenium cell, and the variable current actuated a telephone receiver. In this way demonstrations were given of the transmission of speech and music, and these made, in particular, a wide appeal to the lay mind, a result largely assisted by publicity given by the Press.

No less popular were the demonstrations of the optophone, the purpose of which is to enable the blind to read ordinary printed matter. In this, a selenium bridge is exposed to successions of sets of light pulsations, which vary with the forms of the letters passed over. Characteristic musical sounds are produced in a telephone receiver by each letter, constituting an alphabet readily learned.

The exhibition committee received the support of the National Physical Laboratory and of the Meteorological Office, Air Ministry. The exhibit of the former consisted very appropriately of specimen lenses for use in ships' lights, and master standards of colour for testing the colour screens of ships' lights. These were in accordance with the recommendations made in the Report of the Departmental Committee on Ships' Navigation Lights (1922), and formed an instructive display.

The exhibit provided by the Meteorological Department of the Air Ministry followed closely the lines of demonstrations given by that department at the two previous meetings of the Association, in Hull and Edinburgh. A wireless receiving set was employed to intercept the broadcast messages forming the daily international exchange of weather information, and, from these, weather charts were prepared, and forecasts made for the Liverpool area and the Irish Sea. Visitors were, in fact, able to see in miniature the complete working of a weather forecast service. These demonstrations were supplemented by a display of up-to-date meteorological instruments, and by diagrams and photographs of geophysical interest. Much interest was shown in the record of the recent earthquake in Japan, taken at the Bidston Observatory, and in a set of charts showing the progress of the depression which caused the destructive gales of August 29–30 of this year. One of these charts showed the depression completely defined over the Atlantic by one of the best sets of simultaneous observations from ships ever received in the Meteorological Office, and the accuracy of the forecasts issued on that occasion emphasises the practical importance of such reports.

One impression gained by a visit to the exhibition was that the field covered by the exhibits was not only a wide one, but also that very great care had been exercised in the choice of the material shown, having regard to the position of Liverpool as a great seaport and its location in an industrial area. It is not possible to deal in detail with the many interesting and instructive things which were to be seen, comprising, as they did, many striking exhibits in wireless transmission, in the manufacture of steel, in optical and electrical instruments, in instruments employed in navigation, including the gyro-compass, in the chemical and dye industries, in the manufacture of glass, in chemical apparatus, in recorders for use in the control of fuel combustion, in photography and photomicrography, in meteorological instruments, and in other branches of science and industry. Among the instruments which attracted special attention was K. C. Cox's selenium magnifier (H. W. Sullivan, Ltd.), which was shown working in connexion with a syphon recorder for long-distance submarine cable signalling, and is capable of giving magnification up to ten

thousand times the received signal, and higher in special cases. New wireless apparatus, shown by the Marconi International Marine Communication Co., Ltd., embraced direction finders for use in ships, a special installation for ships' lifeboats including direction-finding equipment, and a duplex telephone set—designed to enable ships within 50 miles of land to communicate by telephony with offices on land, utilising on land the ordinary telephone installation. The last is at present under trial at Southampton in co-operation with the General Post Office. Other very recent apparatus included a small X-ray spectrograph (Adam Hilger, Ltd.), made to the design of Dr. A. Müller, embodying details valuable for the analysis by crystal structure of crystals and powders, and a barograph of special construction for survey work (by Negretti and Zambra). The latter has a range of 4 inches on the chart to represent 1 inch variation of barometric pressure, and the instrument can be set to a standard barometer, anywhere from 25 in. to 31 in. of mercury, the temperature compensation being effective over this range. Mr. S. G. Brown's frenophone was another exhibit on which attention was focussed. This is a new "loud speaker" in which magnification of sound is obtained by an ingenious mechanical device dependent on the great friction existing between cork and glass.

But, in the space of a short article, justice cannot be done to all the interesting and instructive exhibits contained in the convenient and well-illustrated handbook issued by the exhibition committee. The local officers of the Association, the exhibition committee, and, in particular, the chairman of the committee, Capt. F. W. Bain, are to be congratulated on the success of this new departure, and it is to be hoped that they may be rewarded by seeing the present exhibition as the first of a long series in future years.

M. A. GIBLETT.

Terrestrial Magnetism in France.[1]

A DECREE of July 28, 1921, created an Institute of Geophysics attached to the Faculty of Science of the University of Paris, and the new institute has assigned to it the work in terrestrial magnetism previously entrusted to the Meteorological Service. There was established at the same time a Central Bureau of Terrestrial Magnetism for France and her colonies. The director of both bodies is the editor of the volume under notice, Prof. Ch. Maurain. He contributes an historical account of magnetic observations in France, and a study of disturbances due to electric traction. Recent magnetic history in France, as elsewhere, is mainly a tale of the devastating effects of electric traction. Parc St. Maur, which commenced its career as a magnetic observatory in 1883, had to be replaced in 1901 by Val Joyeux, and fears are now entertained for the future of Val Joyeux. There are already two electric lines in the district, one coming within 4400 metres, the other within 3000 metres of the observatory.

A discussion by M. Baldet of observations made at Berizaréa in Algeria represents magnetic work done in the colonies. The greater part of the volume, pp. 38-249, is, however, devoted to a discussion by M. Ch. Dufour of the magnetic observations at Val Joyeux from 1915 to 1921. This practically represents seven years' work rolled into one. In the earlier part of the memoir the results of the same species for the seven years appear in immediate succession. Thus we have $9\frac{1}{2}$ consecutive pages of Fourier coefficients for the diurnal variation of D (declination) and H (horizontal force) calculated for every month from January 1915 to December 1921, while pp. 60-94 are devoted to a description of the magnetic disturbances recorded during the 84 successive months. The principal magnetic storms are dealt with in 23 plates at the end of the volume, Z (vertical force) curves being reproduced as well as D and H. The time scale is only 1 cm. to the hour, and details of rapid oscillations are difficult to follow, especially for the largest storms, among which the storm of May 14-15, 1921, is pre-eminent. A rather unusual feature is that movement up the sheet represents decrease in all three elements. On p. 95 is a résumé of mean absolute values of seven elements at Val Joyeux from 1901 to 1921. The plan of the work then alters, the years being treated separately. The material given for each year has some special features. There are, first, for each month mean daily values for D, H, and Z, and hourly values confined to 6h, 12h, 18h, and 24h. The absolute daily maximum and minimum of D and their times of occurrence are included, and a word or two describes the character of the day. Then follow diurnal inequalities for the 12 months, apparently from all days, for 7 elements, and a table containing mean values for the 24 hours of the representative day of the year, derived respectively from all days and from quiet days. Following this is a most elaborate presentation of results from the five international quiet days of each month. Absolute values are given for each hour of each day for six elements.

The last part of the volume, pp. 250-298, contains a most valuable discussion of the magnetic results at Parc St. Maur and Val Joyeux from 1883 onwards by the veteran magnetician, M. A. Angot, late director of the Meteorological Bureau. This is a perfect mine of information for the magnetician. We have first diurnal inequalities for D, H, Z, and I (inclination) for the twelve months, derived independently from 18 years' records at Parc St. Maur, and from 17 years' records at Val Joyeux, stations both in the neighbourhood of Paris. Then we have diurnal inequalities for seven elements based on the whole 35 years, and ascribed to Paris. Following this there are Fourier coefficients for the 24-, 12-, 8-, and 6-hour waves corresponding to these inequalities. An elaborate investigation is made into the possibility of representing the annual change in the amplitude and phase of the several Fourier waves in terms of the longitude of the sun in its apparent annual path.

Another question minutely considered is the annual variation, meaning thereby the variation left in the mean monthly values of the elements after the elimination of the secular changes, assumed to progress at a uniform rate throughout the year. Use is made of mean monthly values of seven elements from 1883 to 1920, recorded in tables on pp. 278-284. The range obtained for the annual inequality in D, 0·23′, seems the smallest found anywhere as yet, but a suspicious feature in previous results has been the tendency for the apparent range to diminish as the number of years available has increased. For most of the other elements there are quite substantial ranges, *e.g.* 0·80′ in I (maximum in November, minimum in June), and 17·3γ in H (maximum in June, minimum in November). The ranges for these two elements are somewhat larger than those found for Kew[2] from a shorter period of years, but the

[1] Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau Central de Magnétisme Terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome Premier. (Paris: Les Presses universitaires de France, 1923.)

[2] Roy. Soc. Phil. Trans., vol. 216, p. 238.

maximum and minimum occur in the same months at the two stations.

A very complete investigation follows into the secular change, based on a table, on p. 287, of mean annual values at Parc St. Maur reduced to Val Joyeux, and at Val Joyeux, extending from 1883 to 1921. Some small differences may be noticed from M. Dufour's table on p. 95. On p. 288 reference is made to the possible influence of sunspots on secular change. As several magneticians have supposed such an influence to exist, it is important to note that M. Angot's results are wholly negative: "il semble impossible de retrouver . . . la moindre trace d'une périodicité de onze années." Secular change has followed almost identical courses at Paris and London. The change of D in late years has been very rapid, the easterly movement at Paris from 1916 to 1921 being 48·1′. H attained a maximum in Paris in 1912. After falling continuously until 1913, I has been rather oscillatory, there being a rise from 1914 to 1918, but a fall since.

As a final contribution to the subject of secular change, M. Angot has tried to represent the value of D at Paris from 1541 to 1921 by a simple harmonic fluctuation about a mean value. The formula giving the best results is

$$D = 6{\cdot}55° + 15{\cdot}85° \cos 2\pi(t - 1814)/480,$$

t being the date in years. The agreement between this formula and observation is quite good from 1541 to 1891; but since 1881 the excess of the observed westerly declination over that calculated has steadily increased until in 1921 it was 3·2°. The publication of this volume promises well for the future of the new Institute of Geophysics of the University of Paris.

C. CHREE.

University and Educational Intelligence.

THE Department of Aeronautics of the Imperial College of Science and Technology, which was established in 1920–21, has issued a pamphlet showing the courses available during the session 1923–24. The work is conducted in three sections, design and engineering, meteorology, and navigation, and a complete course normally occupies two years, the second often including research and experimental work.

THE university extension division of the University of Colorado exemplifies the wide range of services offered by a modern state university in America. This "division," described as "simply a vehicle by means of which the various departments of the university may be made available to the people of Colorado," includes not only a department of instruction (correspondence, class, vocational, and visual), but also a "department of public service" comprising bureaus of community organisation (for promoting public health, child welfare, recreation, and kindred subjects), business and governmental research, library extension, home-reading courses, high school debating league, high school visitation, and supply of public speakers. The range of public service which the university is willing to undertake is, in fact, limited only by its capacity to perform them.

FOR many years an admirable system of continuative education has been given in Great Britain in H.M. Dockyard Schools. Boys enter the dockyards as the result of competition, and the effect of this is a high standard of teaching in the primary and secondary schools of dockyard towns. When the apprentice has entered the dockyard, he has to attend school for eleven hours each week, partly in the afternoons in his working hours, and partly in the evenings. He is under strict naval discipline during these educational periods, and absence from school without sufficient cause leads to loss of pay, or to suspension or dismissal if the offence is repeated. Attendance is compulsory for every apprentice in the first year, but at the end of each of the four years of the normal course the least successful students are sent away from school. There is thus a continual weeding out of the mentally unfit, with the result that, at the end of the fourth year, the students who remain represent the best products of a wise combination of theoretical and practical training and are able to compete successfully for any scholarships in which applied science and mathematics are given prominence. The announcement of the result of this year's competition for Whitworth senior scholarships and Whitworth scholarships affords a remarkable example of this fact. The number of competitors for the former—of an annual value of 250*l*. tenable for two years—was 19, and for the latter—annual value of 125*l*. tenable for three years—was 142. Of the two senior scholarships awarded, one was to a former dockyard apprentice, now at the Royal Naval College, Greenwich. Of the six other scholarships, four were awarded to dockyard apprentices, and of the twenty-five Whitworth prizes of 10*l*. each given to unsuccessful candidates, twenty-one were awarded to dockyard apprentices. These splendid results are most creditable to the instructors in H.M. Dockyard Schools, and they show that the Admiralty system of education is a potent force for technical training and development in Great Britain.

THE prospectus for 1923–24 of university courses in the Manchester Municipal College of Technology contains the new regulations for the B.Sc. Tech., which provide for higher courses, distinct from, and at least one year in advance of, the ordinary degree courses, to extend over three years from the standard of the present intermediate examination for the degree, or the Higher School Certificate. The college offers courses of post-graduation and specialised study and research in various branches of engineering, applied chemistry and chemical technology, textile industries, applied physics, and mining engineering. The calendar of the Merchant Venturers' Technical College, Bristol, gives particulars of university degree courses, including the Bristol "sandwich" scheme of training for engineers. This comprises three periods of ten months each in the university, followed severally, the first by 14, the second by 2, and the third by 14 months in certain engineering works to which the university undertakes to recommend suitable students. Loughborough College, which has on its Board of Governors representatives of the Universities of Cambridge and Birmingham as well as of the Leicestershire County and Loughborough Town Councils, publishes full details of its equipment and courses in engineering and chemical technology and of its School of Industrial and Fine Art, Junior College, and extramural department, together with a list of some 250 students who qualified in 1922 for the College diploma, conferred for the first time in that year. The diploma course covers five years and its special feature is that, unlike the various "sandwich" systems, it provides for continuously concurrent training in engineering theory and practice. The Sir John Cass Technical Institute, London, announces, among others, special courses of higher technological instruction in brewing and allied industries, petroleum technology, colloids, alternating currents and electrical oscillations, metallography, foundry practice, mining and surveying.

Societies and Academies.

PARIS.

Academy of Sciences, August 27.—M. A. d'Arsonval in the chair.—Jean **Perrin**: Observations on fluorescence. The fluorescence of a solution depends on its concentration, thickness of layer, and light-absorbing power of the solvent. An attempt is made to define specific fluorescence, measurable by a coefficient independent of these factors.—D. **Mordouhay-Boltovsky**: Certain categories of transcendental numbers.—Jules **Baillaud**: The astronomical station of the Pic du Midi. This observatory is characterised by the purity of the sky and clear images. The advantage of the height (2870 metres) is not obtained at the price of undue fatigue on the part of the workers. Observations would appear to be possible except during the late winter and spring months.—A. A. **Guntz**: Phosphorescent sulphide of zinc. The partial substitution of cadmium sulphide in the zinc sulphide gives a more durable phosphorescence and causes changes in the colour of the light. It also renders the phosphorescent sulphides more easy to insolate.—André **Charriou**: The absorption of sodium hyposulphite by photographic papers. The elimination of sodium hyposulphite from photographic papers is much more rapid and complete, if the washing is carried out with solutions of sodium or ammonium bicarbonate instead of with water.—Ch. **Kilian** and V. **Likhité**: The development of *Hendersonia foliorum*.—Maurice **Piettre**: The chemical relations between humic materials and coal.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 9, No. 8, August 1923).—C. **Barus**; (1) The vibration of air in tubes capped at both ends. The air columns are actuated by telephones. Pressure changes are measured by an interferometer U-tube. With H-tubes and straight tubes there is a frictional but no special frequency effect. (2) The vibration of the air filament in quill tubes capped at both ends.—J. P. **Minton** and J. G. **Wilson**: Correlation between physical and medical findings on normal ears. Curves showing the relation between the root mean square pressures exerted on the ear drum by a telephone receiver diaphragm, plotted on a logarithmic scale, and the frequencies, plotted on a linear frequency scale, are used. In most of the fifty-four cases cited, the physical and medical findings for normality of the ear are in agreement.—T. Y. **Thomas**: The Einstein equations of the gravitational field for an arbitrary distribution of matter.—W. T. **Councilman**: The root system of *Epigæa repens* and its relation to the fungi of the humus. The roots of this member of the Ericaceæ, which is found only in America and Japan, are devoid of roothairs; the place of the latter appears to be taken by the hyphæ of a fungus which penetrate between and into the cells of the roots. The roots break up into a number of fine capillaries which ramify the humus near the surface of the soil. The relationship appears to be one of symbiosis.—J. V. **Leech**: The symmetry of the internal ears in flatfishes. Although the left eye of flatfish migrates during development until it comes to lie beside the right eye, the left ear remains in its original position. Examination of the left and right ears of numerous specimens of *Pseudopleuronectes americanus* and *Limanda ferruginea* showed no difference in structure. In consequence, the mode of action of the ears of these fish in equilibration is difficult to understand.—A. **Bramley**: Motion of an electric particle in a Riemann space. An infinitesimal particle revolving about the atomic nucleus describes a definite orbit with constant velocity.—W. M. **Davis**: (1) The marginal belts of the coral seas. The islands in the Pacific, in addition to the formerly glaciated islands of the colder seas, can be grouped in three categories: (*a*) Volcanic islands with cliffs, generally without submarine banks or coral reefs and mostly in the colder seas. (*b*) Islands with cliffs and submarine banks, sometimes with coral reefs; an intermediate or marginal belt about 5° wide between latitudes 25° and 30° north and south of the equator. (*c*) Volcanic islands without cliffs but having lagoons rimmed by coral reefs. The data supports the postulate of unstable islands associated with changes of ocean level and temperature, *i.e.* Darwin's theory modified by glacial control factors. (2) The depth of coral-reef lagoons. The stable rock platform hypothesis for the foundation of atolls is rejected on the grounds of the absence of cliffs and of such platforms on islands thought to represent uplifted atolls. Lagoon-enclosing reefs on subsiding foundations would produce lagoons of moderate depth; increased rate of subsidence would be counterbalanced by increased inwash of detritus. Shallow pre-glacial lagoons would be deepened by continued degradation during the lowering of the glacial ocean. The subsidence theory also accounts for submarine banks at varying depths in the coral seas.

SYDNEY.

Linnean Society of New South Wales, July 25.—Mr. A. F. Basset Hull, president, in the chair.—R. H. **Anderson**: A revision of the Australian species of the genus Bassia. Forty-two species of the genus Bassia are discussed, of which nine are described as new, and four as new combinations. A key to all the Australian species is given.—Jessie K. **Steel**: Anatomical features of the mature sporophyte of *Selaginella uliginosa*. The species is primitive. The radial type of shoots, together with the frequent occurrence of a Selago condition, the mixed arrangement of the sporangia in the cones, and the presence of four megaspores within the megasporangium, all point to a close relationship with the more primitive members of the Lycopodiales.—C. **Hedley**: Studies on Australian Mollusca. Pt. xiv. New species of the genera Hemidonax, Pitaria, and Umbraculum are described. From the Great Barrier Reef a considerable body of species is noted, which were named from New Caledonia and have now extended to Australia.

Official Publications Received.

Department of Agriculture and Natural Resources: Weather Bureau. Annual Report of the Weather Bureau for the Year 1919. Part 3: Meteorological Observations made at the Secondary Stations during the Calendar Year 1919. Pp. 357. (Manila: Bureau of Printing.)

Northampton Polytechnic Institute, St. John Street, London, E.C. Educational Announcements (Evening only) for the Session 1923–1924. Pp. 81-232. (London.)

Department of Commerce: Bureau of Standards. Scientific Paper No. 474: Series in the Arc Spectrum of Molybdenum. Pp. 113-129. (Washington: Government Printing Office, 1923.) 10 cents.

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 17: Educational Surveys. By Prof. Edward Franklin Buchner. Pp 44. Bulletin, 1923, No. 24: Educational Extension. By Charles G. Maphis. Pp. 32. Bulletin, 1923, No. 26: Educational Work of the Young Women's Christian Association. By Education and Research Division, National Board of Y.W.C.A. Pp. 24. (Washington: Government Printing Office.) 5 cents each.

Report on the Zoological Survey of India for the Years 1920 to 1923. Pp. lvi. (Calcutta: Government Printing Office.) 1 rupee: 2s.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Grenada, January–December 1922. Pp. iv+14. (Trinidad.) 6*d*.

Transvaal University College (University of South Africa). Calendar 1923. Pp. 270+6 plates. (Pretoria.)

Ministère de l'Instruction publique et des Beaux-Arts. Enquêtes et documents relatifs à l'enseignement supérieur. 118: Rapports sur les observatoires astronomiques de Province. Année 1922. Pp. 130. (Paris: Imprimerie Nationale.)

Rapport annuel sur l'état de l'Observatoire de Paris pour l'année 1922. Par M. B. Baillaud. Pp. 32. (Paris: Imprimerie Nationale.)

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The British Dye-producing Industry.

IN a letter to the *Yorkshire Post* of September 12, Prof. W. M. Gardiner returns to the national problem of the British dye-producing industry, which is rapidly approaching the supreme crisis in its post-War history. Recognised at the outbreak of hostilities in 1914 as an essential factor in our national security and industrial welfare, the new dyestuffs corporation was then brought into existence in response to a general demand for the establishment of a home manufacture in dyes and intermediates.

Upwards of 7,000,000*l.* of government and private money have been expended in the land, building, plant, and general equipment of the British Dyestuffs Corporation Ltd. alone, and the other makers, of whom there are more than twenty, have also spent large sums in the extension of old works and the erection of new. On the technical side, the chemists employed in this new industry have made advances which are certainly revolutionary. Essential intermediates, hitherto not produced in Great Britain, are now manufactured in large quantities and of superior quality, and the range of British dyes includes eighty per cent. of the present requirements of our dye users.

On the economic side, however, the makers are in a position which is almost desperate. In spite of the fact that shareholders of dye-producing firms have received only meagre return on their capital outlay, the dye consumers are pressing continuously for reduction in prices because their foreign competitors have access to dyewares sold at prices with which no country with a stabilised currency can compete. At present, foreign dyes for which there are British equivalents are not admitted into Great Britain unless the British makers' price is greater than three times the pre-War price, and this measure of protection is being threatened. But even if the makers could get down to pre-War prices, it is doubtful whether the controversy on costs of production would cease, for in existing circumstances the German producer could profitably quote at far lower prices than those prevailing in 1914.

The chemists of the organic chemical industries, including dyewares, have shown themselves capable of the necessary concentration and patience required to build up the new scientific trades, but these essential national developments are doomed to failure in the near future unless the administrative leaders of the country in general, and of the dye-using industries in particular, can acquire what Dr. Duisberg, the head of one of the largest German colour works, speaking during the War, said England lacked, namely: "the faculty of fixing the eye on distant consequences and not merely on monetary results."

More Applications of Physics.

A Dictionary of Applied Physics. Edited by Sir Richard Glazebrook. In 5 vols. Vol. 5: Aeronautics—Metallurgy—General Index. Pp. vii + 592. (London: Macmillan and Co., Ltd., 1923.) 63*s*. net.

THE fifth and final volume of the "Dictionary of Applied Physics," now well known and justly famous, edited by Sir Richard Glazebrook, deals with two of the youngest physical sciences, aeronautics and metallography. The former occupies about two-fifths, and the latter the remainder of the book. The same plan is adopted as in previous volumes, *i.e.* there is a limited number of articles dealing with important aspects of the two sciences, written by men of high standing and authority in their subjects. Interspersed between these is a series of headings in alphabetical sequence, containing references to the articles in question. It is natural that many of the articles should have been contributed by present and former members of the staff of the National Physical Laboratory, Teddington. Whether, however, it was wise to make the proportion so high as it is in the metallurgical section of the volume may be questioned. A dictionary of this kind should represent as wide a range of authoritative opinion as it is possible to secure, and we think that the editor would have been well advised to draw, more than he has done, on the knowledge of metallographers occupying positions in the metallurgical industries.

The section on aeronautics opens with a valuable article on full-scale aerodynamic research by Mr. M'Kinnon Wood. The subject of experimental tests of the strength of aeroplane structures is dealt with lucidly by Mr. William Douglas, while various aspects of the theory of aeroplane structures are comprehensively treated by Mr. Cowley. Two articles by Mr. Guy Barr on aeroplane wings follow, one dealing with dopes, the other with fabrics. Mr. Barr also contributes a lengthy and interesting article on diffusion through membranes. The article on instruments used in air-craft, by Mr. Dobson, deals with many novelties. Prof. Bairstow contributes two articles, written with great authority, on the performance of air-craft and the stability of air-craft. A general outline of the theory of the air-screw is given by Mr. Arthur Fage, who also deals with the helicopter. This article may be studied in conjunction with that recently written by Prof. Bairstow in NATURE (August 18), entitled "The Helicopter: is it worth a prize?" The problem of the helicopter is that of an aerial machine "supported in the air by the thrust of one or more air-screws rotating about the vertical." As the author points out, many of these have been constructed, but only a few have supported their weight in the air, and none has been successful when judged from the point of view of practical utility. Experiments on air-ships constitute the subject-matter of an important article by the late Mr. J. R. Pannell and Mr. R. Jones.

The "engine" side of aviation is dealt with by the late G. H. Norman, Sqd.-Leader, R.A.F., in an article entitled "Air-cooled Engines for Air-craft." This contains valuable data on the comparative performances of air-cooled and water-cooled engines. At the present date the majority of engines are water-cooled, but the author evidently considers that there is likely to be a considerable increase in the use of air-cooled engines in the future. The saving in weight due to air-cooling may not be very great, and may in some cases be counter-balanced by increased head resistance. Its great advantage lies in the lower capital and attendance costs and the simplicity of the engine installation. Prof. J. C. McLennan contributes a short article on the production and use of helium. He estimates that from Empire sources, not more than about 12,000,000 cubic feet per annum can be obtained, the estimated cost being "not excessive." This, as he points out, would only keep a very few of the large air-ships in commission, even if diluted with 15 per cent. of hydrogen. The best method of extraction hitherto discovered consists in producing the refrigeration necessary to liquefy all the gases, except helium, by the cold obtained from the natural gas itself.

The subject of "Model Experiments in Aeronautics, their Theory and Methods," is dealt with comprehensively by Messrs. E. F. Relf and H. B. Irving, and the section closes with an article on "The Hydrodynamical Theory of Wing Surfaces," by Mr. H. Glauert.

Part II. of the volume is entitled "Metallurgy," but almost the whole of the subject-matter relates to what is usually called "Metallography." Dr. Haughton contributes excellent articles dealing with typical alloy systems, the construction of equilibrium diagrams, and the relationship between structure and physical constants. It is a pity that the constitutional diagram of the aluminium zinc alloys, on page 229, has been reproduced, since it is inaccurate in certain respects, and the correct diagram was published more than a year ago. This might well have been used and would have rendered unnecessary the footnote on page 230. Dr. Haughton has drawn his diagrams with the horizontal ordinates indicating weight percentages. It is not clear why he has preferred this arrangement. The system of plotting atomic percentages on the horizontal ordinates has many advantages. The diagram of the iron nickel system reproduced on page 235 is incomplete in the upper range of temperature where the δ to γ inversion of iron takes place. The only metal the

metallurgy of which is described in this volume is aluminium, presumably on account of its use in air-craft, but it is not the only metal used, and it may be questioned whether it was worth while introducing it. The metallurgy of aluminium is adequately described in a number of text-books. Similarly, it is not clear why the electrolytic refining of copper has been singled out for treatment. A general article on the principles of electrolytic refining giving illustrations from various metals, would have been more useful.

Mr. Francis FitzGerald has compressed a remarkable amount of information into his article on electric furnaces. It gives exactly the kind of treatment of the subject that is required in a volume of this kind. Mr. Coad-Pryor has written two articles, both of them very good. That on "Furnaces for Laboratory Use" is of moderate length, while the one on "Refractories" is of considerable dimensions. They are packed full of information and the treatment is admirable. Of very solid merit also are the two articles by Dr. Hanson, one on iron carbon alloys, the other on the defects and failures of metals. The former, however, is rather perfunctory in its reference to cast-iron. It deals with pure iron carbon alloys, and has only a very slight reference to commercial cast-irons containing silicon, manganese, phosphorus, and sulphur. The article on the defects and failures of metals is most valuable. It represents what may be called National Physical Laboratory experience at its best. The author, however, is incorrect in attributing the growth of cast-iron on repeated heatings to the pressure caused by the formation of oxides of iron. The main cause, at any rate, is the volume increase caused by the separation of silica. The statement on page 372 that "a 'crystalline' fracture (one containing bright facets along which rupture of the crystals has occurred—not an inter-crystalline fracture) indicates by the size of the facets, the general size of the crystal structure of the material," is scarcely correct in this unqualified form, seeing how greatly the fracture may be made to vary according to the method of producing it.

Dr. Rosenhain contributes seven articles, and these constitute between one-third and one-quarter of the entire metallographical section. He deals with (1) some special alloys, (2) aluminium alloys, (3) the microscopic examination of metals, (4) the relations of strain and structure in metals, (5) the thermal and mechanical treatment of metals, (6) the thermal study of metals, and (7) the microstructure of metals and alloys. The most considerable of these is the article on the relations of strain and structure and the conception of amorphous metal. The subject is handled with the author's well-known ability. It is well to remember, however, that the conception of amorphous metal is not by any means generally accepted to-day among metallographers, and it may be doubted whether anything is gained by such a sentence as appears on page 397—"At the present moment indeed, even those who, on certain grounds, vehemently oppose this theory have no alternative to offer which can afford any satisfactory explanation of the great group of facts which this theory so readily co-ordinates." In the section headed "Tempering and Quenching" (page 411), Dr. Rosenhain attributes the hardening of a carbon steel by quenching to "the development of a very large number of minute crystallites of both α iron and cementite," and the existence of an "envelope of amorphous iron which is so highly viscous as to be, in effect, an intensely hard solid." As to this, there is no evidence of the formation of cementite in a properly quenched steel. More causes operate in the hardening of steel by quenching in water than are indicated in this article.

Sir George Beilby's striking work on metal aggregates receives attention in two articles written by Mr. W. D. Haigh on the aggregation of solids and the flow of solids. There is a long and very useful article by Dr. W. H. Hatfield on "Special Steels," which, with the valuable article by Sir Robert Hadfield on "Manganese Steels," does something to bring the "works" atmosphere of applied science into this section of the dictionary. The volume closes with a detailed index of the subjects dealt with in aeronautics and metallurgy, and finally with a general index of the principal articles in the five volumes.

H. C. H. Carpenter.

Tubicolous Worms.

(1) *A Monograph of the British Marine Annelids.* Vol. 4, Part 1: Polychæta—Hermellidæ to Sabellidæ. Pp. vii+250+plates 112–127. 50*s*. net. (2) Vol. 4, Part 2: Polychæta—Sabellidæ to Serpulidæ; with Additions to the British Marine Polychæta during the Publication of the Monograph. Pp. xii+251–539+plates 115–117 and 128–138. (Published for the Ray Society). By Prof. W. C. McIntosh. (London: Dulau and Co., Ltd., 1922–23.) 50*s*. net.

THE volumes under notice constitute the last two parts of "A Monograph of the British Marine Annelids." The Council of the Ray Society in the preface to the final volume, issued with the last part, "believe that they are interpreting the feelings of the members of the Society in offering to their President congratulations on the completion of this monograph, of which the first part was published no less than half a century ago." This is an expression in which all zoologists would wish to join, and rejoice that Prof.

McIntosh sees in his eighty-fifth year the completion of his magnificent work. Through the years he has pursued with such admirable singleness of mind, amid many other occupations, the study of this neglected group of marine animals. When he so modestly "hopes that they are left in a better state than he found them, thanks to the greater attention zoologists in every clime have bestowed on the Marine Polychaets," we can only reply that his name stands foremost among investigators of the Polychæta during a period of great and unexampled progress, in which his broad comprehensive studies have been supplemented, and are now necessarily succeeded, by the work of specialists in the different families.

The Ray Society is scarcely less to be congratulated on the way in which it has persevered with the production of the final parts of the monograph during the lean years after the War. So much stands to the credit of the Ray Society in the past for its wonderfully illustrated volumes by Allman, Alder and Hancock, and many others, which have done so much to create the reputation of British marine zoology, that we cannot sufficiently praise the vigour and enterprise, with unimpaired excellence of execution, which the Society still displays. It is earnestly to be hoped that it may receive the increased support from zoologists which it now so greatly needs.

(1) "Such synonymes as would signify *mason* or *potter*, might be aptly applied in explaining the character and habits of the Terebella. Nothing could be more appropriate, for this animal is alike distinguished by address and perseverance in producing works of art." This tribute to one of the despised tribe of worms is paid by Sir John Dalyell in "The Powers of the Creator declared in the Creation," a book which embodies his patient and extended observations on the habits of marine animals. In the first part of the last volume of Prof. McIntosh's great monograph five families of tube-building polychæts are described, the Hermellidæ, Amphictenidæ, Terebellidæ, Ampharetidæ and Sabellidæ, and the first three exhibit in the highest degree that craftsmanship which always awakens a sympathetic chord in the human observer.

The Terebellidæ, of which twenty-four species are here described, is the best known of these families. The basis of the tube which they inhabit is a secretion of the skin glands which often hardens to the consistency of parchment. In this while it is still soft the animal embeds, on the outer surface, the foreign bodies which it so assiduously collects. It is a common but always fascinating sight to see the countless tentacles of a terebellid spreading in all directions from the opening of its tube. With a lens, a multitude of particles can be detected moving along the ciliated groove on the surface of each tentacle, toward the mouth. Prof. McIntosh quotes the following passage from Dalyell describing this never-ceasing activity: "Nothing is more surprising than the attention of so humble an artist being directed towards such a variety of operations at the same time. Many tentacula are searching after the materials—many in collection—many bearing them to the edifice—some quitting their hold—others recovering the load—while the architect itself seems occupied in kneading masses in its mouth, disgorging them successively, or in polishing the rude workmanship resulting from its labours." The worm thus described, the "Potter" of Dalyell, *Amphitrite figulus*, builds tubes of mud, but others like *Lanice conchilega* use grains of sand or even carefully select fragments of shell. There are still more fastidious forms like those Japanese examples mentioned by Prof. McIntosh as collected by the *Challenger*, which gather pine needles and stick them lengthwise on the tube, and in the Cretaceous there occur tubular structures composed of bones and scales of fishes which Bather assigns to the activities of Terebellids.

The Amphictenidæ include such well-known forms as *Pectinaria belgica*, a very abundant worm. The reviewer remembers seeing the Belgian coast in 1917 strewn with millions of this form washed out of the sand after heavy weather. Their slightly curved tubes are miracles of workmanship. Prof. McIntosh in his description of this and other forms has quoted largely from the work and reproduced some of the drawings of Mr. A. T. Watson, to whom we owe so many fascinating accounts of the methods of annelid artificers.

If the tubes of the Terebellids and Pectinaria are usually hidden from view, Sabellaria among the Hermellidæ often forms conspicuous masses of firmly cemented tubes between tidemarks covering large surfaces of rock. Unlike other "social" polychæts (e.g. Filograna, Phyllochætopterus and *Potamilla torelli*, all described in this work) they do not reproduce asexually, and some other explanation must be sought for their gregarious nature.

The Sabellidæ again are among the most interesting of tube builders. The crown of finely divided processes around the head, so beautifully portrayed in Prof. McIntosh's plates, are referred to here (as is usual elsewhere) as branchial, but we venture to think that Bounhiol's experiments, made in 1890, show that they have no special respiratory value. But, indeed, the comparative study of the respiration of the tubicolous worms offers a very profitable investment for the time of a biologist.

(2) In the second part of Vol. 4 the description of the Sabellidæ is continued, and the last family, the Serpulidæ, is treated. Here the tubes are always

calcareous, and one of the cephalic filaments is usually modified to form an operculum. One of the most interesting features of the family is the remarkable pigmentation of the cephalic filaments, often very variable in the same species, giving the animal a charming flower-like appearance, a phenomenon which has still to be investigated thoroughly. Among British species the condition is best developed in *Pomatocerus triqueter*, which, nearly everywhere, whitens the stones and rocks between tidemarks. Other characteristic British forms, amply treated here, are *Serpula vermicularis*, so often attached to the shells of Pecten in the coralline zone, and Filograna, the coral-like masses of which are frequently taken in the dredge.

Lastly there is an addendum of no less than seventy-eight species which have been discovered or described as British, too late to appear in their proper places. Of the many co-workers whom the author cites as responsible for these additions to the British fauna, there must be specially mentioned Mr. Southern, of the Irish Fisheries Department, who, working in the years just before the War, at Clare Island and elsewhere, obtained a plentiful harvest of unsuspected forms, including eighteen entirely new species. "Truly the riches of the marine fauna of the west coast of Ireland are by no means exhausted," Prof. McIntosh is constrained to exclaim, and we must hope that Mr. Southern may be able to complete his faunistic work.

The wonderful charm of the drawings by the late Mrs. Gunther and Miss Walker, and the success of their reproduction, have so often been commented upon by reviewers of earlier parts that we can do no more than re-echo their praise. One feature of the volume is, however, almost unique: that is the bibliographical collation of the parts as issued, compiled with the index by Mr. G. A. Smith.

Universities and National Life.

The Older Universities of England: Oxford and Cambridge. By Albert Mansbridge. Pp. xxiv+296+8 plates. (London: Longmans, Green and Co., 1923.) 7*s*. 6*d*. net.

MR. MANSBRIDGE scores with both barrels. He appeals to both of the classes into which (relative to his book) the world is divided—those who have been at a university and those who have not. In any case, although he has the detachment which comes from never having been through the university mill himself, he not only loves and appreciates the university and what it stands for, but also has actually added something to its nature and functions. By his initiation of the Workers' Educational Association, he gave a new and fuller content to the whole extra-mural side of university activity, and helped to spread the universities' influence more rapidly and more extensively than could have been done in any other way. Add to all this that he was a member of the recent Royal Commission on Oxford and Cambridge, and it will be seen that he has advantages that the most learned historian cannot despise.

For it is as a historian that Mr. Mansbridge, wisely enough, chooses to treat his subject. In his pages we see the genesis of English universities in the ferment of the twelfth century, the beginnings of the college system, its expansion by such men as William of Wykeham, Henry VI., and Wolsey, the involvement of the universities in politics, the submergence of their original purpose beneath the flood of wealth and birth in the eighteenth century, the gradual reappearance of that purpose from the middle of the nineteenth century onwards, the adjustment of the curriculum to modern needs, the growth of a new university organ in extra-mural education. . . .

We are not allowed to forget the continuity and vitality of the current of scholarship and learning, nor to lose sight, under a mass of academic detail, of the university's position in the body politic. Nor is that all; Mr. Mansbridge, for all his idealism (which may prove almost embarrassing to a certain type of overworked and matter-of-fact "don"), can appreciate and even be affectionate to the failings of Oxford and Cambridge. The noblemen and gentlemen-commoners, even at their most foppish, amuse him; he sees through to the human heart below donnishness, and smiles indulgently on port.

For this alone the book is worth reading—because it is a short and well-written and appreciative history of our two oldest and greatest seats of learning. But it is worth reading for more important reasons. It is worth reading by the university-trained man, partly because Mr. Mansbridge's wistful regret at his own lack of that training helps to fuller realisation of its meaning and values, and partly because his concern for the extension system and the W.E.A.'s fine work puts the university in a new setting for him, relates it to new aspects of national life. It is worth reading also by all those who have not received a university education and yet are concerned in any way with domestic politics, because it will help reveal to them what a university can and should be—what an ideal to the individual, what a force in the community.

Mr. Mansbridge is a rebuke to the diehard (generally Tory, practical, and well-to-do), who exclaims that education is a curse and a burden and higher education in particular an unpractical folly; and a rebuke no less to those violent spirits of the Left who see in all universities, and especially in Oxford and Cambridge, some

dodge of capital, and hate the aristocracy even of learning. To him the university is simply the corporate and social expression of civilisation's mind; and, as with the mind of an individual, although its fullest cultivation is in one sense a luxury, yet in another and broader view, it is the highest necessity.

Avian Minstrelsy.

Songs of the Birds. By Prof. Walter Garstang. Second edition. Pp. 115. (London: John Lane, The Bodley Head, Ltd., 1923.) 6*s*. net.

We have before us the second edition of this agreeable and very suggestive little book, the original issue of which was noticed in Nature of August 12, 1922. A new song has been added and two passages have been revised, but otherwise the alterations are merely verbal. Mr. Shepherd's quaint little sketches of the songsters again add to the pleasure of the reader.

The book, we may recall, begins with an important essay in which Prof. Garstang discusses the nature of avian song, the rôle it plays in the life of the birds, and the very interesting evolutionary aspects of the subject. From that he proceeds to the vexed question of the symbolic representation of song, and after having propounded his thesis on this point he begins his series of representations of the music of the different species. The reasons which he gives for the adoption of his particular form of representation cannot fail to carry some measure of theoretical conviction to the reader, based as they obviously are on a thorough appreciation of bird song aided by a knowledge of music and a sense of poetry. It is harder to apply the practical test as to whether the representations do indeed convey more adequately than former attempts an idea of the various songs, for one has to bear in mind the existence of individual differences both in the hearing of the songs and in the interpreting of the written symbol: one hesitates, indeed, to express a definite opinion until students of the subject have had further experience in using the new method. If, however, either these "first fruits" of Prof. Garstang's studies or some future elaboration of them can in time be regarded as making possible the adequate representation of different songs on paper, he will have succeeded in making good a deficiency of which the present existence is evident in every text-book of ornithology.

In the preface to the new edition the author replies vigorously to such of the reviewers of his first edition as were hostile in their criticisms, and in so doing he also takes to task our own by no means unappreciative notice for not having discussed his auxiliary verses from a scientific point of view. Lest we may seem unjust in this respect we may here quote Prof. Garstang's own account of his method and of the part which his verses play therein: "The peculiar quality or *timbre* of each bird's voice and the resonance of each sound have been imitated as closely as possible by a selection of human consonants; the composition of the song has been represented by the appropriate repetition, modification, or contrast of selected syllables; the syllabic rendering has been cast in a corresponding rhythm; and round this chosen sequence of syllables a song has been woven to capture something, if possible, of the joy or of the attendant circumstances which form the natural setting of his song." We have certainly no wish to quarrel too seriously with our author as to where scientific method properly ends and where more emotional vehicles of thought properly begin. In his new preface he quite truly says that "The exploration and illustration of the borderlands of Science and Art will not end with my adventure": we may add the hope that even his own adventure into these fields is by no means concluded.

Prevention of Vibration and Noise.

The Prevention of Vibration and Noise. By A. B. Eason. (Oxford Technical Publications.) Pp. xii + 163. (London: H. Frowde and Hodder and Stoughton, 1923.) 15*s*. net.

This volume, as the author states in his preface, does not profess to contain anything not already known, but is a more or less classified account of the work of various experimenters on the subject of which it treats. Beginning with a useful but not complete bibliography, and a note on the problems to be investigated, later chapters treat of "annoying" vibrations and their amplitude; the means and apparatus which have been used to measure them, the vibrations of buildings, bridges, and other structures; means of damping vibration, the transmission and isolation of noise; and ending with an account of balancing machines, *i.e.* machines for determining whether, and how much, any revolving part is out of statical or dynamical balance.

As showing what has been done in these matters. the book is useful for reference, but its value would have been much increased by a more critical examination of the elements of the whole subject. It is difficult in many places to know whether the author is giving his own views or restating those of the experimenters whose results he summarises.

In defining "annoying" vibration, scarcely sufficient attention is given to the differences in surrounding conditions. What would be "annoying" in Mayfair might be unobjectionable in Poplar. Where wood or asphalt pavement prevailed, the introduction of granite

sets would certainly cause complaint. In describing the different forms of apparatus which have been used for measuring vibrations, no hint is given as to the trustworthiness of the results. This is an important omission, for in the greater number of those instruments the records are an imperfect catalogue of peculiarities of the instrument rather than of the magnitude of the external vibrations which they were designed to measure. All such instruments have natural periods of their own, and one of the most important points in their design should be to arrange that neither the slowest nor any of the more rapid natural periods shall approach those of the imposed vibrations, and since in most cases the imposed vibrations are (like white light) made up of a great many arbitrary disturbances, this is not a condition which it is easy to fulfil. Many mistaken diagnoses have been made from neglecting the effects of resonance on the recording apparatus, and from supposing that a large recorded amplitude necessarily indicates a large external vibration.

Perhaps the most interesting chapter is that on the isolation and damping of sound, in which many examples are given of successes and failures in practical attempts in this direction. In most of these the actual results might have been anticipated. In speaking of the minimum audible sound (as in reference to the least sensible vibration) insufficient prominence is given to the effect of the surrounding conditions. In an absolute silence many experiments have shown that a sound, the wave amplitude of which is a twenty-five millionth of an inch, can be heard, but in the midst of other noises, if the amplitude of the loudest of these is taken as unity, another sound with an amplitude of 1/15 is only just audible, so that the greatest and least intensities which can be appreciated simultaneously are something like two hundred to one.

With regard to the isolation of sound, an absolute barrier to the propagation of vibrations may be set up either by complete reflection or complete absorption, but when the amplitude is large and the absorption rapid, a gradual change may probably occur in the absorbent. The secular change in the efficiency of sound-absorbing materials is not mentioned.

In reference to the acoustic qualities of halls and rooms, most of the experimenters whose work is quoted seem to consider that "good" and "bad" depend on the rate at which vowel sounds and musical notes are damped, but it is not uncommon to find rooms which are good for music but bad for speech, and it is the effect of the resonance of the room on the consonants rather than on the vowels which determines whether spoken words are clearly heard.

Though there are many published papers on the subjects which come under the head of "vibration," Mr. Eason's is the only book in which any collection of their results has been attempted, and notwithstanding some defects (chiefly of omission), it should form a very useful addition to the literature of the subject. A. M.

Our Bookshelf.

Advanced Practical Physics for Students. By B. L. Worsnop and Dr. H. T. Flint. Pp. vii+640. (London: Methuen and Co., Ltd., 1923.) 21*s*. net.

TEACHERS of experimental physics will find much that is useful and suggestive in this volume. Though some experiments of an elementary character have been included, the work is intended for advanced students who are working for a pass or honours degree. The bulk and the price of the book might have been reduced materially by the omission of much that is common to many elementary text-books. In some cases full experimental details are given, while in others the description is insufficient to enable an ordinary student to carry out the necessary manipulations. Little attention is given to the degree of accuracy to be expected.

Many recent experiments and modern forms of apparatus have been described. We may mention in particular the determination of the ratio of the charge to the mass for an electron by means of the Zeeman effect using a Lummer-Gehrcke plate, and also by Sir J. J. Thomson's method. From the account given in the book the student might infer that the latter method is due to Braun. There is a useful chapter on the quadrant electrometer (in which Wheatham should be Whetham), and a section on the three-electrode valve.

The most striking feature of the work is the stress laid on the theoretical side of the subject, the aim being to make the course practically independent of other treatises, at least as regards immediate reference. To aid this scheme an introductory chapter on the calculus has been included.

It is to be regretted that the proof-sheets were not submitted to a literary critic, as there are too many examples of careless or ungrammatical construction, and the punctuation needs amendment in many places. The wholly inadequate table headed "Units" needs revision: the value for the electrochemical equivalent of hydrogen has long been superseded, and to give the charge on an electron as $4 \cdot 71 \times 10^{-20}$ E.S.U. is unpardonable.

Mechanical Testing: a Treatise in Two Volumes. By R. G. Batson and J. H. Hyde. Vol. 2: Testing of Prime Movers, Machines, Structures and Engineering Apparatus. (The Directly-Useful Technical Series.) Pp. xi+446. (London: Chapman and Hall, Ltd., 1922.) 25*s*. net.

THE first volume of this work dealt with the testing of materials of construction; the present volume concludes the treatise and contains a great deal of matter which will be of service to all who are interested in the testing of machines and structures. The selection of a suitable dynamometer is of vital importance in the testing of an engine or machine, and, roughly, one-quarter of the volume is devoted to different types of this instrument. This section includes traction dynamometers such as

are used in railway work, and the Lanchester machines for the testing of worm gears. Other sections deal with lubricants, friction tests on bearings, vibration tests, and static and dynamic balance.

The part of the volume devoted to tests on structural elements contains methods of testing concrete slabs and beams, plain and reinforced, and also columns of various types. Much of the work which has been done on this subject has been carried out in America, and we note that the authors have dealt justly with it in the space at their disposal. Tests on cutting tools, aircraft models, and other miscellaneous tests conclude the volume. As was the case in the first volume, a good deal of the apparatus described is installed at the National Physical Laboratory, but the authors have not forgotten that research cannot be confined to one place, nor to one investigator or group of investigators. The complete treatise will be welcomed by all who are engaged in the testing of engineering materials and appliances.

(1) *Oil Power.* By S. H. North. (Pitman's Common Commodities and Industries.) Pp. ix+122. 3*s.* net.
(2) *Internal-Combustion Engines.* By J. Okill. (Pitman's Common Commodities and Industries.) Pp. xi+126. 3*s.* net.
(3) *The Diesel Engine.* By A. Orton. (Pitman's Technical Primers.) Pp. x+111. 2*s.* 6*d.* net.
(London: Sir Isaac Pitman and Sons, Ltd., 1923.)

THE general reader who desires information regarding oil fuel and the practical methods of using it will find much of interest in these three little books. The greater part of (1) is occupied with descriptions of oil burners as used in furnaces. This system is employed to a large extent in marine and locomotive boilers. The question of oil storage at various ports is of vital importance for the supply of oil-fired vessels, and is dealt with towards the end of the volume. The first thirty-two pages in (2) are devoted to the gas engine, and the greater part of the remainder deals with oil engines of different types. The book is up-to-date in the matter of the engines selected for description, and there are sections on aero-engines, tractor engines and turbines. The Diesel engine is of sufficient commercial importance now to warrant a separate volume, and this is provided in (3). Here we find descriptions of the arrangements and methods of working of both four-stroke and two-stroke Diesel engines, and a short discussion of the power developed and the efficiency. The student of heat engines will of course require a great deal more than is contained in these books. They are, however, very suitable for those readers who wish to be informed as to what has been accomplished in this important branch of engineering.

British Museum (Natural History). British Antarctic (Terra Nova) Expedition, 1910. Natural History Report. *Botany*, Part 3: Lichens. By O. V. Darbishire. Pp. 29-76 + 2 plates. (London: British Museum (Natural History), 1923). 7*s.*

DR. DARBISHIRE's account of the lichens is the third of the reports to be issued on the botany of Captain Scott's Antarctic expedition of 1910. Reports on the seaweeds (by Mr. and Mrs. Gepp and Mme. Lemoine) and on the freshwater Algæ (by Dr. Fritch) were published in 1917.

Seventeen species were collected, eight of which proved to be new, and are described and figured in the present publication. With the exception of one Lecidea, the new species belong to the genus Buellia. The lichens were all found on rocks, mainly granite and gneiss, at Cape Adare and Evans Cove in South Victoria Land. When describing the lichens brought back by the Swedish Antarctic Expedition (1901-3) in 1912, Dr. Darbishire gave a summary of the species known at that time from the Antarctic area; their number was 107; this has now been increased to 208, mainly by the material brought back by the second French Antarctic Expedition of 1908-10, which was reported on by the late Abbé Hue. The value of the present brochure is enhanced by the inclusion of a complete list of the species recorded from the Antarctic area, that is, from localities to the south of the 60° S. parallel, to which are added keys to the genera and species. Twenty-three per cent. of the species are also found in the Arctic regions, and the author notes a striking similarity of the Arctic and Antarctic lichen flora in regard to the proportion among the known species of the chief lichen forms.

The Preparation of Plantation Rubber. By S. Morgan. With a Preface and a Chapter on Vulcanisation by Dr. H. P. Stevens. Pp. xvi+331. (London, Bombay and Sydney: Constable and Co., Ltd., 1922.) 21*s.* net.

BOTH editions of Mr. Morgan's useful book on plantation rubber are now out of print, and in preparing a third edition the opportunity has been taken to revise completely the original work, and to incorporate in the new volume the results of the experimental research in practically all branches of the business of preparing rubber for the market which has been carried out by Mr. Morgan in the course of his work as Scientific Officer to the Rubber Growers' Association in Malaya. In doing so, the book has been virtually re-written, and it now forms a complete and authoritative guide to the modern practice of a rubber plantation, from the planting of the tree to the packing of the rubber for export. The subject has been usefully rounded off by the addition of a series of three chapters on the vulcanisation of rubber, including an account of the methods of testing the material for industrial use. This section of the book has been specially written by Dr. Stevens, consulting chemist to the Rubber Growers' Association in London, and is based on the researches on vulcanisation carried out by him for the Association over a period of about ten years. Altogether the volume is an admirable handbook, and with periodical revision should remain the standard work on the subject.

Die Stereoskopie im Dienste der Photometrie und Pyrometrie. Von Carl Pulfrich. Pp. iv+94. (Berlin: Julius Springer, 1923.) 3*s.* 4*d.*

THE physiological optical effect on which the photometrical method made use of in the instruments described in Prof. Pulfrich's book is based was described in NATURE of May 12, p. 648, and May 19, p. 691. In one of Prof. Pulfrich's instruments a pair

of fixed and moving marks is employed, which is observed by both eyes simultaneously through a pair of telescopes provided with a suitable system of prisms; in others two pairs of marks are made use of, one of which is seen in the middle of the field of view of each of the two telescopes, so that the appearance is that of a single pair. The two moving marks are geared together, and driven either by hand or by a small hot-air motor. If the fields of view of the two telescopes are equally "bright," the mark appears to move to and fro, horizontally, in a straight line, its point passing just above the point of the fixed mark; a difference of brightness makes it appear to revolve round the fixed mark. This is independent of the colour of the two lights which are being compared. It is also possible to adjust the two sides of the apparatus to equality of brightness with an accuracy of 2 to 3 per cent., however great the difference of colour may be, provided the observer has sufficient experience, and good spectroscopic vision. In the stereospectral photometer, two monochromators are employed, one for each telescope, so that practically monochromatic light of different wave-lengths can be employed. A form of photometer, which enables one-half of the spectrum to be balanced against the other half, promises to be valuable in pyrometry.

Malaya: the Straits Settlements and the Federated and Unfederated Malay States. Edited by Dr. R. O. Winstedt. Pp. xi+283. (London, Bombay and Sydney: Constable and Co., Ltd., 1923.) 12*s.* net.

This authoritative and comprehensive handbook will come as a boon to all who are interested in or in any way connected with the Malay Peninsula. The editor, a well-known authority and the author of several works on the Malayan language, is himself responsible for the chapters on the population, the ethnology, and languages of the Peninsula; Malayan literature; arts and crafts; religion and beliefs; and history and archæology, as well as the account of the Eurasian, Chinese, and other races of the country.

Other chapters are the work of experts in their respective departments. Mr. J. B. Scrivenor, the Government Geologist, describes the geography, geology, and mineralogy of the country, as well as its mining industry. Dr. F. W. Foxworthy deals with the flora and forests, and Mr. F. C. Robinson of the Federated States Museum with the fauna. Mr. B. J. Eaton, Director of Agriculture, deals with this and other industries, while Mr. Pountney, Financial Adviser to the Straits Settlements, analyses revenue and expenditure. The sections on the Straits Settlements, the Federated and Unfederated States, which will be found particularly helpful, are the work of the editor. An adequate, if not lengthy, bibliography is an excellent guide to those who seek further information. The book is well illustrated and well produced.

A Tested Method of Laboratory Organisation. By S. Pile and R. G. Johnston. Pp. xx+98. (London: H. F. and G. Witherby, 1923.) 7*s.* 6*d.* net.

The authors of this little book were associated with a co-operative laboratory established during the War by a number of Birmingham brass firms, and their conclusions are mainly based on experience gained in that laboratory. They give many useful notes on the equipment and arrangement of works and control laboratories, on the preparation of samples, and on the methods of recording the source of the sample and the results of its examination, whether analytical, mechanical, or physical. Their treatment of the subject of laboratory books and the entering of results is very thorough, and they go so far as to describe a system of costing in units by means of which a monetary value may be attached to each operation. While the scale of the work is too small for it to serve as a manual of laboratory equipment, it will be found particularly useful by those who have to instal a small laboratory in a works, especially in one of the metallurgical industries. The question of the relations between the superintendent and his staff is also dealt with, but the closing chapters, under such headings as "The Mentality of the Scientist," seem rather out of place in an essentially practical note-book.

Among Unknown Eskimo. By J. W. Bilby. Pp. 280+16 plates. (London: Seeley, Service and Co., Ltd., 1923.) 21*s.* net.

The Eskimo of Mr. Bilby's title can be accurately described as "unknown" only in relation to the public for whom he writes—a public which normally does not have access to scientific publications. His account of the customs, modes of life, and beliefs of the Central Eskimo of Baffin Land is, however, something more than a book with a merely popular appeal. A residence of twelve years among these tribes qualifies him to give ritual and belief their proper setting and perspective in the everyday round in a manner which is not always possible in an analytic study. This has a value which anthropologists will readily acknowledge; but Mr. Bilby's intense appreciation of the native attitude of mind to tribal observances, and his keen insight into the dynamic relation of such observances to conduct, have obscured the fact that these do not necessarily tell the whole story. Accordingly, he is prone to offer as an interpretation of native practices the immediate social effect and the psychological factors which come into play in certain elements of ritual, to the neglect of deeper causes. An appendix gives a valuable list of some fifty departmental deities of the Eskimo with their attributes.

Edmund Loder; Naturalist, Horticulturist, Traveller and Sportsman: a Memoir. By Sir Alfred E. Pease. With Contributions by St. George Littledale, Charles G. A. Nix, Lord Cottesloe, J. G. Millais, and W. P. Pycraft. Pp. x+356. (London: John Murray, 1923.) 18*s.* net.

The friends and acquaintances—and of a man so accomplished and of such wide interests as was Sir Edmund Loder, these are many—will be glad to possess this "miniature" of his remarkable personality. Sir Alfred Pease has not attempted to depict a life-size portrait; but by wise selection, and with the assistance of other contributors, he succeeds in conveying a very clear impression. The reviewer can perhaps pay no higher tribute than by stating that though he was not privileged to know Sir Edmund personally he closed the book with the feeling that he knows well what manner of man he was.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Control of Malaria in the Malay Peninsula.

BEFORE Sir Ronald Ross's epoch-making discovery, there was no more puzzling problem in medicine than the cause of malaria; no secret in Nature more cunningly hid than the malaria secret. Malaria was known to be connected with swamps, and to be reduced by drainage and cultivation. Yet, as if merely to confuse, men found that to flood some swamps actually improved health; and elsewhere that drainage and the cultivation of the soil produced the most serious and devastating outbursts of the disease. Yet again, malaria was found not only in swamps, but also often on hills and dry sandy deserts. Some jungle-covered land was singularly free from malaria: other jungle land was intensely malarial. In fact, malaria existed on soils of every conceivable variety, of every age in geological time. It was impossible to point to any mineral, chemical, or vegetable condition essential to its presence. It was, and had been for hundreds of years, a dark, inscrutable mystery.

Sir Ronald Ross's genius changed darkness to light, and inaugurated a new era in tropical colonisation. To many, of course, the discovery that malaria was carried by mosquitoes merely confirmed them in their pessimism that the control of malaria was beyond human effort. They were wrong; and briefly I give two examples of what has been done in the Malay Peninsula in the past twenty years under different physical conditions. I would premise that the places of which I speak are within three degrees of the equator, have a rainfall round about 100 inches a year spread throughout the year, that the country as a whole is naturally covered by an ever-green damp jungle, and that mosquitoes exist in myriads at all times. One example is of malaria on low-lying land; the other of malaria on hill land.

CAREY ISLAND.

Twenty years ago or less, if the tropical sanitarian had been asked what was the class of land least likely ever to be freed from malaria by the control of mosquitoes (or by any other means for that matter), he would unhesitatingly have named the low-lying coastal land, with high ground-water, heavy clay soil, liable to flooding from the sea. He could easily have justified his choice. Such land had ever been known to be pestilential almost beyond description; it had given rise to innumerable speculations on the cause of malaria—the decay of coral, the mixing of fresh and salt water, to name but two. In every part of the tropical world examples of the deadly power of malaria in coastal regions could be given. In the Malay Peninsula and Archipelago, for example, the Governor, Sir Frank Swettenham, in 1901 ordered the new port called after himself to be closed, so overpowering was the malaria. On the opposite side of the Straits of Malacca, the port Belawan in Sumatra was so malarial that the Dutch left it every night, retired to a town some twenty miles inland, to return by the first train the following morning. Many other examples could be given.

Carey Island is situated on the coastal belt of such land. It is, indeed, an island just above sea-level in its highest parts, and obviously has been formed by the alluvium from the hills. Surrounded by water, on one side by the sea, on others by large rivers or riverine estuaries, containing salt water, it is fringed by mangrove swamps and covered by dense virgin jungle. Throughout its length and breadth it was swamp, either of fresh water or salt.

In 1906, a pioneer planter of Malaya, the late Mr. E. V. Carey, took up a concession of 30,000 acres on the island and began the planting of rubber and coconuts. The island was bunded and drained. Tide gates were necessary. Enough was known of the control of malaria to enable the labour to be kept free from malaria from the first, and opening rapidly proceeded. To-day some 14,000 acres (or roughly 20 square miles) are under cultivation. No European —of a population of from 20 to 30—has contracted malaria on the island since 1912. In 1922 the average Asiatic population was 4344. There were 26 cases of malaria, 14 clinical cases, and 12 in which parasites were found. This is a rate of 6 per mille. The lowest rate recorded in Panama was 14 per mille. There were at the end of last year 962 children, of whom 9 or 0·9 per cent. had enlarged spleen. In about all, but not absolutely in every case, both adult and child, there is reason to believe the infection had been contracted elsewhere. Steps are now being taken to end the last possible source of malaria, namely the disused and neglected wells in the small private gardens of the coolies. When these are properly supervised, I am convinced malaria contracted on the island will be as unknown as malaria contracted in the centre of London. The death-rate of the labour force in 1922 was 8·2 per mille. This freedom from malaria has been achieved by good drainage and by the selection of suitable sites for buildings. It costs the Estate practically nothing; while the absence of malaria makes the Estate one of the cheapest producers of both rubber and coconuts in the East. This is an example of the control of malaria carried by two species of anopheles, namely *A. umbrosus* and *A. Ludlowi*.

THE CITY OF SINGAPORE.

Following the control of malaria in the coastal regions, a new and apparently even more difficult problem confronted us, namely, malaria on hill land. In the ravines or valleys, when under jungle, malaria was carried by *Anopheles umbrosus*; when the jungle was swept away, when, for stagnant swamps in the valleys, swift clean running streams were substituted, malaria was of even greater intensity; in many places death claiming over 300 out of every 1000 of the population per annum. The mosquito carrier which lived in these streams was *Anopheles maculatus*. It is not my purpose here to detail the various methods by which this malaria has been successfully controlled, even in small rural areas; it has been done at a cost well within the reach of a commercial undertaking; indeed the money spent has been recovered within a short period by the greater efficiency of the labour and a lowered cost of production.

I prefer rather to speak of the excellent work done in the city of Singapore. Prior to 1911 a malaria wave swept over the city almost every year. As will be seen from the chart (Fig. 1), it generally reached its maximum in the month of May. In 1911 I was asked to advise the anti-malaria committee, and drew up plans for the control of malaria in a selected area. The late Dr. W. R. C. Middleton was then Health Officer. For the first two years Dr. Finlayson was seconded for the supervision of the work, which was carried out by Mr. McGee, the engineer engaged

for the purpose. Since 1914 the work has been under the control of Dr. P. S. Hunter, now Health Officer of Singapore. He has extended the area greatly; to him the success of the work is mainly due. Dr. Hunter has also extended the work to the fortified island of Blakan Mati, with great advantage to the garrison. Indeed Singapore has now ceased to be malarial, so far as the troops are concerned. The area under mosquito control is almost six square miles. There are 8¾ miles of concrete channels and

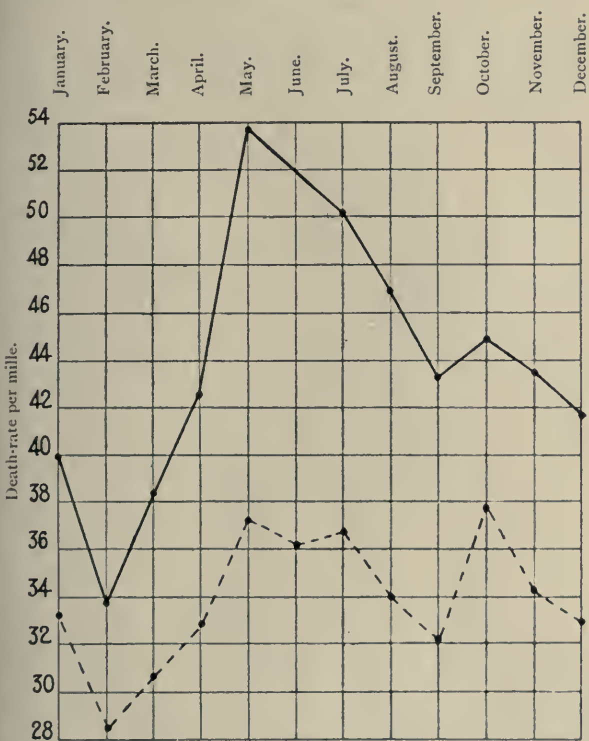

FIG. 1.—Death-rates of city of Singapore.
Average 1903–1912 •——•——•
Average 1913–1922 • – – • – – •

31 miles of subsoil drainage. A sum of approximately 350,000 dollars (say 38,000*l.* sterling) has been spent on capital and maintenance accounts. This year there is a vote of 100,000 dollars (say 12,000*l.*) for maintenance and extension of anti-malarial and general anti-mosquito work.

Further details will be found in the chapter on the "Malaria of Singapore," which Dr. Hunter contributed to my "Prevention of Malaria in the Federated Malay States" (London: John Murray, 1921): see also NATURE, March 16, 1922, p. 334. Following the anti-malarial work, the spleen rate of the children fell progressively from about 50 to zero. The great malarial wave, which raised the death-rate in the month of July 1911 to 85·83 per mille, has been so flattened that the influenza peak of 1918 is now responsible for the highest point. The wave will not entirely disappear until the work in Singapore is completed, and until the surrounding country ceases to dump its sick on the city. Anti-malarial work is being extended into the rural districts by Dr. Scharff.

The peak of the malarial wave in May averaged

	per mille.
for the 10 years 1903 to 1912 . . .	53·76
,, ,, 1913 to 1922 . . .	37·27
a reduction of	16·49

The average annual death-rate from all causes was

	per mille.
for the 10 years 1903 to 1912 . . .	44·11
,, ,, 1913 to 1922 . . .	33·73
a reduction of	10·38

The average population 1913 to 1922 was	312,763
The saving of life is therefore . .	32,214

The saving of life is from all medical and sanitary measures, but the most important is the control of mosquitoes.

Finally, I may add that in the 25 years since Sir Ronald Ross's discovery, more than 100,000 lives have been saved in Malaya alone, owing to that discovery; and the work is just beginning.

The Far Eastern Association of Tropical Medicine meets in Singapore this year. Arrangements have been made to show members over the anti-malarial work in Singapore, and an excursion to Carey Island has been arranged.

MALCOLM WATSON.

Klang, Federated Malay States,
June 24.

Some Consequences of the Gravitational Deflexion of Light.

THE results of the eclipse expeditions of 1919 and 1922 leave little doubt that the deflexion of 1·75″ predicted by Einstein for a ray of light passing close by the sun is a fact. Moreover, as a result of the experiments of Lebedew and Poynting, it is admitted generally that such a ray possesses momentum as well as energy. It does not appear to have been noticed that these experimental results lead to certain important consequences when they are combined with the generally admitted principles of conservation of momentum and of energy.

Let us suppose for the sake of argument that the energy of the ray of light, and consequently also the *magnitude* of its momentum, remains unaltered in spite of the deflexion. Since the *direction* of the momentum has been changed, its component along the real axis of the approximately hyperbolic path has been reversed; if we retain the principle of conservation of momentum for the system sun-light-ray, we conclude that the sun has acquired momentum along the real axis and therefore kinetic energy also. According to the principle of conservation of energy, the energy of the light-ray must have diminished by an equal amount—a conclusion which contradicts the original assumption. Thus we are led to a dilemma: either we must reject one or other of the two principles of conservation of momentum and of energy for the action between the light-ray and the sun, or we must admit that the energy of the light-ray has diminished, as well as its momentum.

It is difficult to imagine a mechanism by which the energy lost by the light-ray is transferred to the sun on the wave theory, though no doubt the pressure of light will play the predominant part, but it is obvious according to the quantum theory. Without entering into details, which must be reserved for a future paper, I may be allowed to refer to one important consequence of the assumption that the light-ray loses part of its energy, namely, that its wave-length is increased by a small amount.

In fact, if the deflexion be δ, the light quantum makes the angle $(\pi-\delta)/2$ with the major axis initially and finally on opposite sides of it. Consequently its loss of momentum in that direction is $(2\nu h/c)\cos(\pi-\delta)/2$, or $(2\nu h/c)\sin\delta/2$ with the usual notation, and this is also the gain of momentum of the sun. Hence the energy transferred is equal to $(2\nu^2h^2/c^2m)\sin^2\delta/2$, where m is the mass of the

sun, and it is also equal to $-h\Delta\nu$, where $\Delta\nu$ is the increase of frequency of the light quantum. Thus $\Delta\nu = -(2\nu^2 h/c^2 m) \sin^2 \delta/2$, and $\Delta\lambda = -c\Delta\nu/\nu^2 = (2h/cm) \sin^2 \delta/2$, a value which is independent of the wave-length, at any rate if δ be so.

For a light quantum passing close by the sun we have $m = 2 \,.\, 10^{33}$ gm., $\delta = 1{\cdot}75'' = 8{\cdot}5 \,.\, 10^{-6}$ radian; hence with $h/c = 2{\cdot}18 \,.\, 10^{-37}$ we find $\Delta\lambda = 3{\cdot}9 \,.\, 10^{-81}$ cm., a change which is far too small to be detected by experiment.

If, however, we assume that the negative electron behaves like a very minute gravitating mass, though acting according to a different law on account of its charge, we obtain a connexion with A. H. Compton's recent quantum theory of the scattering of X-rays (*Physical Review*, May 1923, p. 483). Although this theory in its present form does not account for the excess scattering, it is very successful in explaining the small scattering of γ-rays as well as their softening. To this extent it supports the present view of the deflexion of light. I have worked out the orbits of light corpuscles for a gravitating electric charge, but the full discussion of the results and of their bearing on the structure of the electron must be reserved for the paper already referred to.

G. A. SCHOTT.
University College of Wales, Aberystwyth,
September 3.

Suggested Botanical Exploration of the Higher Summits of the Cape Verd Islands.

IT is somewhat surprising that in our much explored world there is still a group of large islands in the Atlantic which in a botanical and probably also a zoological sense may be said to be imperfectly known. For until we know what lives on the cloud-capped summits of islands like Fogo and San Antonio, which attain elevations of 8000 and 9000 feet above the sea, it can scarcely be said that the Cape Verd Islands have been scientifically explored. Surely here would be a good piece of work for an English yachtsman and two or three investigators from Lisbon. Allowing two weeks for each island, the examination of Fogo and San Antonio would only involve about a month's absence from St. Vincent, the assumed starting-place, and a host of botanical and other curiosities would be gathered in the deep ravines and on the uplands of those mountainous islands. With government aid it could be carried out by one of the learned societies of Lisbon.

Fogo is reckoned to be the healthiest of the islands, and it promises to be the most interesting for the naturalist. But whoever goes will have to be prepared for living in damp conditions, as in perpetual fog and mist.

Anything may be in hiding on those cloud-capped uplands. Concealed in the ravines may still survive plants that have become extinct in other Atlantic groups, or which exist only in islands of other oceans or in distant parts of the world, such as the Tree-Compositæ of St. Helena, the Tree-Labiatæ of Juan Fernandez, the Tree-Lobelias of the mountains of tropical Central Africa.

Then, again, American genera, like Clethra, that have died out in the Canary Islands, may still survive in the Cape Verd group, and the same may be said of numerous other plant-types that have died out in other parts of the world, or are almost extinct there. Within the rain-belt of these mountainous islands may still linger remains of once predominant laurel woods and their associated plants, such as are now so characteristic of the Azores, Madeira, and the Canaries.

The most significant features of island-floras are presented in their connexions with distant regions, and it is on this feature that are largely based the hopes of important results arising from the examination of the summits of the mountainous islands of the Cape Verd group. Thus, Tree-Lobelias link Hawaii in the Pacific Ocean with the highlands of Kilimanjaro in tropical Africa; the islands of Bourbon and Mauritius in the Indian Ocean possess species of Acacia trees that are scarcely distinguishable from a tree common in the Hawaiian mountains. So again the affinities of the endemic genera of Juan Fernandez connect its flora with St. Helena, the Canary Islands, and the Chatham Islands. The distant connexions of the endemic genera of the Socotran flora are equally remarkable. They cover much of the globe and are found in Asia, Africa, and America.

As Hooker urged in his lecture on insular floras, islands have frequently served as sanctuaries for plant-types that have become extinct on the continents, and in the same way we would expect the Cape Verd Islands to harbour the kith and kin of many plant-types that have failed in the struggle for existence in distant parts of the world.

We cannot afford to let slip opportunities of this kind for increasing botanical knowledge. The island of Fogo has probably already lost much of its original flora through the agency of the woodcutter, and not many trees remain. Barker-Webb, Hooker, Schmidt, Krause, Vogel, Christ, Hemsley, and Coutinho have done much to elucidate the plant-history of the Cape Verd Islands, but the most interesting features of their flora may be not yet disclosed.

H. B. GUPPY.
Red House, Fowey, Cornwall,
August 29.

Polar Temperatures and Coal Measures.

I THANK Mr. Bonacina for his sympathetic comment in NATURE of September 22, p. 436, on my letter on "Polar Temperatures and Coal Measures" and for the added clarity he has brought to this subject. He mentions disagreement with me on one minor issue only, and that relating to the south polar regions. In that connexion I am glad of the opportunity to confess that my thinking on the subject of polar coal measures has really been based almost exclusively upon my knowledge of the Arctic. My suggestion that similar conditions might explain Antarctic coal was a sort of parenthetical remark made without any special consideration of the Antarctic problem.

Mr. Bonacina says: "I do not, however, fully support Dr. Stefansson in expecting that a lowland south polar continent surrounded by an ice-chilled ocean would be liable, at least so often, to the high summer temperature of the Arctic lowlands." A reading of Mr. Bonacina's letter in comparison with mine will show that this partial disagreement is apparent only, due to my faulty expression. I did not mean to say that if the postulated low Antarctic continent were somewhat larger than the actual present continent, high temperatures would be as frequent there as they would be in the Arctic if the land masses of North America and Asia were connected across the North Pole by continuous low land. All I meant to say was that such a hypothetical low southern continent might have temperatures high enough for the development of a coniferous forest.

Mr. Bonacina gives the explanation which I have supposed correct for the lowering of summer temperatures in the northern Mackenzie valley by almost continuous winds blowing from the north.

He suggests that such winds would be even more persistent in the hypothetical southern continent. In that connexion we must remember that in spite of the northern cold summer monsoon the Mackenzie coniferous forest does extend more than 150 miles north of the Arctic circle, and indeed north of the southern limit of the maximum "tides" in the Mackenzie (by tide we here mean the rise of five or six feet in the eastern Beaufort Sea caused occasionally by westerly gales. The tide, proper, is less than one foot).

No such extremes as the occasional Arctic +95° F. are necessary for the prosperity of conifers. Mr. Elihu Stewart, the Forestry Commissioner of Canada, put on record in the publications of his department (in 1907 or 1908) that he had seen trees 100 feet high more than 100 miles north of the Arctic circle in the Mackenzie delta. Trees above 75 feet in height abound forty or fifty miles farther north. I do not know of any systematic temperature observations taken in the Mackenzie delta at the approximate northern limit of the conifers, but I suppose that 70° F. in the shade is there exceedingly rare. I should judge then that any hypothetical conditions in the Antarctic considered adequate to produce maximum temperatures of 75° F. (even though rarely) would give an adequate heat factor for coniferous forests.

VILHJALMUR STEFANSSON.

New Court, Middle Temple, E.C.4,
September 5.

Can the Geostrophic Term account for the Angular Momentum of a Cyclone?

IN meteorological discussion it is sometimes implied that the rotative velocity of the air comprising a cyclone is primarily accounted for by the geostrophic term in the equation of motion.

If considerations of a second order of magnitude be ignored this hypothesis is capable of simple treatment in its main features and is worth examination. Imagine an initial circulation round an axis, of any magnitude whatever, and consider an elemental mass δm at distance r from the axis.

The radial velocity of this element is then denoted by dr/dt taken positive outwards.

The increase in the angular momentum of δm about the axis in time δt due to the geostrophic term is

$$2\omega \sin \phi \,.\, r \,.\, \delta m \,.\, \delta t \frac{dr}{dt},$$

taken positive clockwise in the Northern Hemisphere.

In the limit this becomes $\omega \sin \phi \,.\, \delta m(2r \,.\, dr)$, or $\omega \sin \phi \,.\, d(r^2 \,.\, \delta m)$.

If ϕ be taken as constant, and we sum up for the whole mass of the cyclone, we see that the increase in the total angular momentum in a given time is equal to the product of $\omega \sin \phi$ into the corresponding increment in the moment of inertia about the axis.

The extent to which the moment of inertia can vary is represented by the deepening or filling up of the cyclone, and a rough calculation shows that the possible angular momentum so accounted for is very small, and is, moreover, of the opposite sign to that required by the hypothesis under consideration.

In the above analysis two things have been ignored: (1) The question of the variability of ϕ; (2) the resistance of the earth's surface. If it be supposed that there is a systematic difference between the latitude of the surface inflow and that of the outflow above, there is the possibility of the existence of a term of appreciable magnitude in the case of a large cyclone. On this point observational evidence is weak, and all that can be said is that for a small system the effect must be small, and for large ones we have no reason to suppose it to be large.

The resistance of the earth's surface continually tends to reduce the rotational velocity, and the magnitude of the term concerned is, moreover, large compared with (1), which is of the nature of a differential effect.

On the whole, it seems clear that the angular momentum of a rotating system cannot be accounted for by the geostrophic term, and that its origin must be sought in the initial relative velocities of masses of air subsequently included in the circulation.

L. H. G. DINES.

Benson, Wallingford, August 31.

Zoological Nomenclature: Spirifer and Syringothyris.

IN accordance with prescribed routine, the Secretary of the International Commission of Zoological Nomenclature has the honour herewith to notify the members of the zoological profession that Miss Helen M. Muir Wood, of the British Museum of Natural History, has submitted the generic names Spirifer, Sow, 1816, and Syringothyris, Winchell, 1863, to the International Commission, for suspension of rules, with the view of retaining *Anomia striata* Martin as genotype of Spirifer, and *Syringothyris typa* (s. *Spirifer carteri* Hall) as genotype of Syringothyris.

The argument is presented: (1) that under the rules *Anomia cuspidata* Martin is type of Spirifer, and Syringothyris is synonym of Spirifer: (2) but for seventy years, practically all authors have, in conscious opposition to the rules, taken *A. striata* as type of Spirifer, and *Spirifer carteri* s. *Sy. typa* as type of Syringothyris: (3) so many species are involved in this instance that the application of the rules would present greater confusion than uniformity.

The secretary will postpone vote on this case for one year, and invites expression of opinion for or against suspension in the premises.

C. W. STILES,
Secretary.

Hygienic Laboratory, Washington, D.C.

Colour Vision and Colour Vision Theories.

PROF. PEDDIE states in his letter in NATURE of September 8, p. 362, that the facts that I have given as totally opposed to the trichromatic theory can be explained by it. If he will show how this can be done I can then deal with his explanations. Directly the trichromatic theory is put in a definite form its failure becomes evident. For example, it has been stated frequently by others that the construction of the trichromatic theory given to explain simultaneous and successive contrast will not explain colour blindness, and *vice versa*. There is no fact that directly supports the trichromatic theory. In numerous cases papers written to support the trichromatic theory are found on examination to give facts strongly adverse to it. Prof. Frank Allen has written a number of papers supporting the trichromatic theory. In a paper on the Primary Colour Sensations (*Philosophical Magazine*, vol. xxxviii., July 1919, p. 81) Prof. Allen writes: "But it is difficult to understand why the exceedingly complex region between $\lambda \cdot 470\,\mu$ and $\lambda \cdot 570\,\mu$ should exhibit, as it does, persistency curves with only one elevation in the green." The reader should note that it is only on the trichromatic theory that this region is complex. On my theory it is quite simple and the results should be as stated.

F. W. EDRIDGE-GREEN.

London, September 10.

Transport and its Indebtedness to Science.[1]

By Sir HENRY FOWLER, K.B.E.

PROBLEMS of transportation have been solved more or less successfully in all ages, and some of them, such as the moving of stones to Stonehenge, etc., still excite our wonder and admiration. Such works, and similar ones of much greater magnitude in the East, could be accomplished by quite crude methods if there was unlimited labour available, and if time were of no consequence. The transportation which aids civilisation is that which cuts down the wastage of power to a minimum and reduces the time occupied in carrying this out. It is here that science has helped in times past, and will help increasingly in the future if we are to go forward. In no other branch is Telford's dictum that the science of engineering is "the art of directing the great sources of power in Nature for the use and convenience of man" so well exemplified, and this utilisation has been carried forward at ever-increasing speed during the last hundred years. If we take the definition of science as "ordered knowledge of natural phenomena and of the relations between them," as given by W. C. D. Whetham in the "Encyclopædia Britannica," we shall easily see how transportation has been dependent upon it.

Transport is mainly dependent upon three things—the method of propulsion, the material available for use, and the path over which traction takes place. I propose to confine my remarks to the first two. Advance in traction really became rapid when methods of propulsion other than those of animals and the force of the wind became available. The greatest step forward—wonderful as some of the achievements of aeronautics have been of recent years—came with the development of the steam engine.

Like most great achievements in the world, it was not a lucky and sudden discovery of one individual, although here as elsewhere we associate the work with the name of one man especially. This has usually been the case, and without wishing to detract from the work of the individuals who are fortunate enough to utilise the ordered knowledge available to the practical use of man, one must not forget the labours of those who have sought out that knowledge and have given it freely to the world, thus placing it at the disposal of the one whose imagination and creative faculty were great enough to see how it could be utilised in the service of man.

The first attempt at traction by using a steam engine was a failure because of the lack of this knowledge. I refer to the work of Jonathan Hulls and his attempt in 1736–7 to apply a steam engine to the propulsion of a boat on the River Avon in Worcestershire. He failed because of the lack of that knowledge, although undoubtedly he possessed the necessary imagination.

Although James Watt is not directly associated with traction, it was his application of science to practical use that finally gave the greatest impulse to transportation that it has ever had. No advance had taken place after Newcomen's engine of 1720 until Watt's work of 1769. His knowledge of Black's work at Glasgow on the latent heat of steam, and his own experiments with the Newcomen model, led to the success of his improvements of the steam engine. His scientific knowledge is clearly shown in his patents and publications, for he dealt with steam jacketing in 1769, with expansive working in 1782, and he devised his parallel motion in 1784. His direct connexion with transport includes the reference to a steam carriage and a screw propeller in 1784, while the firm of Boulton and Watt corresponded with Foulton for a period extending from 1794 to 1805.

Although Cugnot in 1770 and Murdoch in 1786 had made models of vehicles propelled by steam, it was Richard Trevithick with his steam carriage in 1801 and 1803 and ill-fated railway in 1804 who first showed the practical application which could be made. It is probable that the engine which his assistant, Steel, took to the wagon-way at Wylam in 1805 turned the thoughts of George Stephenson to the work that has meant so much for us.

No one can read the early life of the "father of railways" without appreciating that he was from young manhood a searcher after scientific knowledge. The advances he gave to the world of transport were all due to his practical application of the knowledge he had obtained himself or had learned from others. It is so often thought that because the early inventors and engineers of the beginning of last century had not received what we now call a scientific education that they were not in any sense of the term men of science. It must be remembered that at that time the knowledge of natural phenomena was very limited, and it was possible to know much more easily all the information available on a subject than at the present day, when we have such a mass of miscellaneous information to hand on every conceivable subject. It was ordered knowledge which led Stephenson to adopt the blast-pipe of Trevithick. It was the desirability of obtaining ordered knowledge that caused him to carry out those experiments which showed to him the advantages of using rails, and it was the scientific appreciation of the necessity of increased heating surface that made him adopt the suggestion of using tubes through the water space in the boiler of the "Rocket." His appreciation of the advantages of science was shown by his acceptance of the presidency of the Mechanical Science Section (then as now Section G) of the British Association in 1838, and it is interesting to note that one of the earliest grants in Section G was for a constant indicator (for locomotives) and dynamometric instruments in 1842–43, while Stephenson was still alive.

From the time of Stephenson the progress in propulsion on rails by steam locomotives was steady if slow. The investigations for a long while were largely confined to the question of expansion and condensation, and although the results attained were noteworthy in the case of steamships, on the rail there was little advance in the principle of propulsion, although the improvements in materials allowed a steady growth in power and size. Although work was done by compounding and using higher pressures, the greatest

[1] From the presidential address delivered to Section G (Engineering) of the British Association at Liverpool on September 14.

advance came to steam locomotives by the use of superheated steam. This was no new thing, for Papin in 1705 seemed to have an appreciation of its value. As pressures and the resultant temperatures increased there came difficulties with lubrication. With the increased use and knowledge of mineral lubricants Dr. Schmit was in 1895 able to devise methods of using superheated steam which have been of the greatest use to transport and to the community.

In spite of the fact that the idea of the utilisation of steam for giving rotary motion is old, its commercial adaptation in the turbine is modern. Rarely, if ever, has there been such a direct and instantaneous application of science to practice. We are too close at present to the matter to realise what a change has taken place in the world owing to the introduction of the steam turbine. One realises the work done by De Laval, Curtiss, Rateau, and the brothers Ljungstrom, but the name which will always be associated with the steam turbine as firmly as that of James Watt is with the inception of the steam engine is that of Sir Charles A. Parsons. The success of his work is due to his application of scientific principles to the many points of the turbine and its accessories. Apart from its application to marine work, it has made possible the economical production of electrical energy, which is doing so much, and will do so much more in the future, for rail transport.

The last means of propulsion that I can deal with is the internal-combustion engine. This, as we almost universally have it to-day, is the result of the cycle adopted by N. A. Otto in his gas engine in 1876. Here again the engines we have are the result of careful and studied investigation, and the advance made has been so much more rapid than in the case of the steam engine and electrical machinery because of the more advanced state of scientific knowledge.

In relation to transport the work has proceeded on two distinct lines, the Daimler and the Diesel engines. In 1885 Gottlieb Daimler produced the engine associated with his name, which utilises a light spirit supplying a carburetted air for the explosive mixture for the cylinder. The development of this engine has itself proceeded in two directions. In one it has been made very much more flexible and silent in its adaptation to motor-car work, while in the other the great desideratum has been lightness and in association with the improvements in the necessary materials has rendered possible the aeroplane as we have it to-day. In both cases the development to the degree reached has been due to a careful study primarily of the pressures, compression, and composition of the mixture.

The Diesel engine was invented in 1894 by Rudolph Diesel, and works by the injection of oil or pulverised fuel into the engine cylinder. Its development has taken place both on the four- and two-stroke cycle, and although considerable progress has been made with land engines, it has been used chiefly for marine transport.

The internal-combustion engine has not been largely used for rail transport owing to its comparatively high cost of fuel per horse-power and its lack of flexibility. The latter is particularly the case when one remembers the high torque desirable, which can be attained in both the steam and electric locomotives in starting.

The early efforts of Hulls have been mentioned, and it was only natural that the work of Watt on land should be followed by application of the new power available to propulsion on the water. Although the growth after the work of Symington, Fulton, and Bell may have seemed to be slow, it was continuous, and constant experiments and research were made both in marine engines and in their application. Saving of fuel has played a much more important part here than with the locomotive, and since more space was available and greater power required, the advantages of the expansion of steam were rendered more imperative and had greater scope than in the other long-established method of mechanical transport. The great advance came with the turbine, and it is interesting to notice that whereas in early days engines were geared up, most of them now are geared down to the screw. Scientific methods have been applied to all those details of measurement and experiment that have led to transport by sea being carried on at increased speed and with decreased cost per ton carried. The application of liquid fuel and the introduction of Diesel engines, both with the object of increasing the space available for cargo, have been carried out on true scientific lines.

Of transport by road it may be said that its commercial inception came at a time when scientific knowledge was well advanced, and its progress was in consequence more rapid. The development of the motor-car engine is a case of the careful application of the fundamental principle developed with ever-increasing care until we get engines as noiseless, as efficient, as trustworthy, and as flexible as we have them to-day.

Much could be said of the indebtedness of aeronautics to science, but I will only speak of the aeroplane. It was not until the development of the internal-combustion engine that the matter became really practical. The War was naturally a great incentive to the advancement of our knowledge of aeronautics. In the means of propulsion, research has given an engine of such size and so light in weight per horse-power that what was a laboured struggle against the effects of gravity has changed into the ability to rise at considerably more than 1000 feet per minute to heights where the rarefaction of the atmosphere renders it necessary for oxygen for breathing to be obtained artificially. The safety of flying as the result of the work of Busk has rendered the machines stable even in such a medium as the air. There is no greater example of the indebtedness of transport to science than the rapidity with which the possibilities of transport by air have advanced.

The other point I would deal with in some detail is the question of materials. We, to-day, have no basic metal or material which was not known when transport first turned to mechanical methods for assistance. The change which has come about has been as largely due to the advances made in metallurgy as to the inventions in mechanics that have led to the improvements in means of propulsion and in machinery. The early builders of steam engines were not only troubled through inability to get their engines machined properly, but also with the difficulties of obtaining suitable material for the parts they required. Steel has been known for thousands of years, but its rapid

and economic production is of very recent growth. It has very truly been said that every great metallurgical discovery has led to a rapid advance in other directions. I will as before deal with the railway as an example.

We can scarcely appreciate now the conditions which existed from a metallurgical point of view on our railways when the British Association first met at Liverpool in 1837. Iron—made laboriously, heterogeneous in character and expensive of production not only in money but also, owing to the heavy character of the methods employed, detrimental to the very character of the workman—was the only material available for the various parts of the mechanism of the locomotive and for the rails. However improved the methods of manufacture were, there could never have been a universal development of rail traction if it had depended upon material made in such a way.

The demand was met at the Cheltenham meeting of the British Association in 1856 when Bessemer made public the invention he had already been working on for two years, which was to ensure a cheap method of production of a material so essential to transport. One should also mention with Bessemer the name of Mushet, whose work helped so materially in getting rid of the red shortness which in the early days gave such trouble. We are apt at the present day to belittle somewhat the work of Bessemer in view of the more improved methods now employed, but his name must for ever stand out as the one who made cheap transport possible. After the use of manganese in one form or the other as a deoxidiser and a "physic" for sulphur, there remained, however, the baneful effect, due to phosphorus, which prevented the use of the ores of more general occurrence. There have been few more epoch-making announcements made at meetings of technical subjects—although this was not appreciated at the time by many of the audience—than S. G. Thomas's announcement of the discovery of the "basic" process, which he made at the meeting of the Iron and Steel Institute in March 1878. His work, associated with that of his cousin, Gilchrist, was the result of close scientific research.

Another investigation which has given great results in transport has been the ever-growing use of alloy steels. For the scientific inception of these we owe a great debt to Sir Robert Hadfield. His first investigations materially affect transport to-day. Mushet had previously worked on self-hardening tool steel containing tungsten, but the work was only carried out on a small scale. In 1882 Hadfield had produced manganese steel. This is a most remarkable product with its great toughness, and is extensively used for railway and tramway crossings, where resistance to abrasion is of great value. This was the first of a remarkable series of alloys which have made possible the motor car and the aeroplane as we have them to-day.

Continuing his investigations, in 1889 Hadfield produced the compound of iron and silicon known as low hysteresis steel. Indirectly, this is of the greatest interest from a transport point of view, for when used in transformers it not only reduces the hysteresis losses, but also allows of a considerable saving in the weight of core material.

From these early uses of alloy steels there has grown up a large number of alloys, many of which are of the very greatest use for various transport purposes. It is not too much to say that the modern aeroplane is the result of the material now at the designers' disposal both for the engine and for the structure itself. The strength of some of the chrome-nickel steels combined with their ductility is extraordinary, and is due not only to the composition of the metal, but also to the results which have been obtained by patient scientific investigations relating to their heat-treatment. Taking one other example, one may quote the use of high chrome steel—for the early investigations into which we owe so much to Brearley, and to its later developments to Hatfield also—for the valves of aeronautical engines, subjected as they are to high temperatures. At one time it looked as if the advantages which follow high compression and its resultant high temperature might be lost owing to the inability of ordinary steel to resist this heat, but the employment of 13 per cent. chrome steel allowed work in this direction to be continued.

It is not only with steels that we have been benefited so much from research. The case is as marked with light alloys, which have aluminium as a base. The latter itself is the result of investigation along scientific lines, and in aeronautical work particularly much has been done towards giving a metal both light and strong by the work of Walter Rosenhain, F. C. Lea, and others.

It may be said that all I have dealt with up to the present has been the result of special investigation, and that "ordered knowledge" is not of assistance to an everyday engineer. The results I have obtained with the assistance of my colleagues, especially L. Archbutt and H. A. Treadgold, dealing with the solid locomotive crank axle are of interest in this connexion. Not only is the axle subjected to stresses set up by revolving it while it is loaded with the weight of a portion of the locomotive on its axle-bearings and by the steam pressure on the pistons transmitted to the crank-pins, but it has also to withstand the shocks set up by its running on the rails, which cannot be calculated. For about twenty years we have endeavoured to get the knowledge we have obtained into an ordered state, from observation and discussion with the metallurgists attached to the various manufacturing firms. Certain points are obvious, such as the necessity of a good micro-structure, and we can with confidence say that the steel "shall be as free as possible from non-metallic enclosures, and that the micro-structure should show uniformly distributed pearlite in a sorbitic or very finely granular or lamellar condition and be free from any nodular or balled-up cementite. It must also be free from any signs of segregation and from any coarse or overheated structure." (Extract from Midland Railway specification for crank-axle forgings.) Toughness rather than strength is required, and the studied consideration of these points has led to an increased life in miles of the crank axles of the 3000 locomotives owned by the Midland Railway Company, in spite of the fact that they have been constantly growing in size, in pressure on the pistons, and in the work expected from them.

It will be appreciated that the above result, which

is unquestionably the result of "ordered knowledge of natural phenomena and the relation between them," is only one example, if perhaps the most marked one, in our experience. A somewhat similar record could, however, be written on locomotive tyres and other matters.

I think I have shown adequately the debt which transport, as well as other branches of our profession, owes to the study of "ordered knowledge." That in the future this will be even more marked than at present, one can say without fear of contradiction. Not only so, but there must be more and more interdependence between science and engineering. More and more as we advance in the knowledge of natural phenomena will the necessity of the practical application of this knowledge on a large scale become necessary, to confirm it and to bring out fresh features.

The Influence of Science on Christianity.[1]

By Canon E. W. BARNES, F.R.S.

IT is a commonplace that all religions, even though their formularies and sacred books seem to guarantee absence of change, are constantly modified. Unless religion is moribund it is dynamic and not static. It is a living process within the spirit of man; and, as such, it is profoundly affected by the ideas and emotions of the community in which it exists. Religious thought and feeling alike are influenced, for good or ill, by contemporary political, social, and intellectual movements. During the last century there has been a movement of human thought as influential and as valuable as that of Renaissance humanism. The assumptions and methods of science have affected the whole outlook of educated men. In particular, those branches of science which are concerned with the domains of physics and biology have radically changed our conceptions both of the structure of the visible universe and of the development of life upon this earth.

The effect of the scientific movement, alike on organised religion and on private faith, has been prodigious. In any circumstances it would have been far-reaching. But unfortunately, representative Christian leaders, with the eager support of their communions, opposed the new scientific conceptions as they appeared. Science was then compelled to fight for autonomy on its own territory; and, as Dr. Hobson says in his recently published Gifford lectures, the result has been a prolonged struggle "in which theology has lost every battle." As a consequence it is now widely believed by the populace that Christianity itself has been worsted.

At least a generation must pass before it is generally recognised that, with regard to religion, science is neutral. Educated men know that the traditional presentation of the Christian faith must be shorn of what have become mythological accretions. But Christianity resembles a biological organism with a racial future. In the struggle for existence it gains strength and power by utilising its environment. It seeks both freedom from old limitations and increased mastery of hostile forces. Amid all change its essential character is preserved, for it rests on historical facts combined with permanent intuitions and continually repeated experiences of the human spirit. The great pioneers, whether in science or religion, are few. Men usually accept both scientific and religious truth at second-hand. The expert speaks with the accent of what seems to us to be unmistakable authority. We make such imperfect tests as we are able to apply to his teaching; and perforce rest content.

We must never forget that all human activity, and not merely those aspects which we call science and religion, rests upon unproved and unprovable assumptions. The existence of such assumptions is often ignored. They are there, none the less. Often lazily and hazily we conceal them under the term "common-sense." Faith, however, is a necessity of existence. Zealots sometimes have contended and still contend that there is a moral value in blind faith. But the modern world, so far as it has fallen under the sway of scientific method, demands that faith shall be reasonable and not blind.

In science we build upon the assumption that the processes of Nature can be represented by schemes that are, to us, rational. There is, we postulate, a unity between Nature's processes and the working of the human mind. The address given this year by the president of the British Association shows how extraordinarily fruitful this assumption has proved to be. But, when we consider the vast domains of science which still remain to be explored, we must grant that the rationality of the universe remains a postulate of reasonable faith. As we pass from science to philosophy and religion, we have to assume the existence of a universal Mind in order to bind together the sequences of phenomena which science observes and describes. Then, as the basis of religious faith, we further assume that the values, which we instinctively deem supreme, express the quality of this Mind to whom all natural process is due. We thus assert that goodness, beauty, and truth are not private values of humanity, but attributes of God.

The different processes of the human mind, thought, will, and feeling, cannot be decisively sundered. As a consequence, the search for truth made by men of science has in our own time profoundly affected our religious outlook. Science has not merely created a new cosmogony against which, as a background, religion must be set. But, as the character of its postulates and the extent of its limitations have become more clear, science has given us a new conception of what we mean by reasonable faith. In so doing, it has strikingly altered the way in which we approach religion. Some old modes of argument and their attendant dogmas have rapidly become obsolete. A great gulf has opened between constructive and merely defensive types of theology. Among religious communions there is, in consequence, much confusion, some bitterness, fear of change combined with recognition of its necessity. The direct influence of science

[1] From a sermon preached in the Lady Chapel of Liverpool Cathedral on Sunday morning, September 16, in connexion with the visit of the British Association to the city.

and its more obvious triumphs are known to all. The earth is not the centre of the universe; its age must be measured by hundreds of millions of years; man upon it is the derivative of lower forms of life. No orthodox theologian, in classical or medieval times, held or would have dared to assert such facts. Henceforth they must find their place in any dogmatic scheme of faith.

The indirect influence of scientific method, its patient induction, its readiness to admit divergent conceptual representations of observed facts, its absence of exaggeration, its hostility to evasive language, and, above all, its abhorrence of argument which pretends to be free but is pledged to reach assigned conclusions—this influence has not yet made itself fully felt. Theological thought, which claims to be scientific and is still widely accepted, preserves bad traditions. The work of the best contemporary theologians is free from blame. But to any one familiar with the scrupulous honesty of modern scientific research the dogmatic inconsequence of much current religious apologetic is painful. For this reason young men and women, who have had a scientific training at our universities, often complain bitterly that they cannot get adequate religious teaching. They have no more desire for undogmatic religion than for hazy science. But they demand that religious dogmas shall be taught with the same frankness, the same readiness to admit progress through change, the same absence of elaborate and unnecessary complication as they are accustomed to get in scientific instruction. Especially do they resent the use of archaic language, which they suspect, not always unjustly, to be used as a cloak beneath which awkward problems are concealed. As the influence of the methods of scientific investigation increases, the dissatisfaction to which I have alluded will spread. There is only one way in which accredited religious teachers can overcome it. They must use scientific method. They must avoid, whatever the cost, the snare of obscurantism.

At the present time we suffer from what I feel forced to regard as an unfortunate development in the religious history of England. A century ago the dominant type of English religion was evangelical. The language used had at times the over-emphasis which is common in devotional literature; but men spoke of realities which they had experienced. That their convictions were genuine, their good works abundantly showed. Their faith was a power. Unfortunately it was joined to a cosmology which was fated to be destroyed by the progress of science. The ravages made in their scheme by geology were already ominous in the year 1823. The faith, it was felt, was in danger. Wisdom pointed to the acceptance of new scientific truths. But it is given to few to "greet the unseen with a cheer." So the Tractarians, the religious reformers who then arose, men of piety and ability, turned to the past for safety. The system which they embraced not only contained the cosmology now repudiated by educated men, but was also a synthesis of religious ideas of pagan origin combined with philosophic concepts now obsolete. English religion is still struggling with this burden: and, as I see the matter, no healthy reconciliation between science and organised Christianity is possible until it is cast aside.

Men of science can do much to help the community during the period of transition through which we are now passing. Their reverence for truth can be made an inspiration of especial value to pious souls. Among men of science there is the moral austerity without which the finest intellectual work is seldom, if ever, achieved. During the last generation, moreover, they have shown a steadily increasing sympathy with religion, an enhanced appreciation of the unique power of Christianity, at its best, to serve the human race, to foster spiritual progress while preserving spiritual freedom. I would urge all men of science whom my words may reach to take every opportunity to set forth their religious ideals, to show how, in their own minds, Christianity and science interact. Personally I think it unreasonable to demand that their language should be orthodox. The great master to my thinking is Hort, the only theologian of the nineteenth century who began with a thorough scientific training; and Hort said progress in theology must come "by perilous use and perilous reform." A faith worth having needs no artificial protection. Individually each one of us may make mistakes: in the end truth will prevail through honest argument. The religious sincerity of able men with trained minds is of value in itself; and, I am convinced, the essentials of Christianity will survive by their own inherent strength.

The Swiss National Park.[1]

By Prof. C. SCHRÖTER, Federal Technical High School, Zürich.

SELDOM has a movement of a purely idealistic character spread so rapidly and victoriously through the world as the movement to protect Nature against the civilisation which threatens to overwhelm it. Everywhere is heard the cry, "save, what may yet be saved, of the original face of mother earth."

Many are the tasks of those engaged in this movement: the preservation of natural geological monuments and prehistoric sites, the protection of rare plants, fine old trees, interesting plant-communities (*e.g.* those of moorland, steppes, or dunes), and the prevention of the extermination of animals. But most effective and profitable of all is the creation of Nature reserves where landscape, plants, and animals alike being protected from the encroachment of man, the sway of Nature is paramount. Such areas may be called "Complete Nature Reserves" or, to borrow an American term, "National Parks."

In 1906 a movement arose in the Schweizerische Naturforschende Gesellschaft, which resulted in the formation of a Commission for Nature Protection, with Dr. Paul Sarasin, of Basel, as president. This

[1] For the translation of the original manuscript the author is much indebted to Prof. R. H. Yapp, University of Birmingham.

Commission, which consists of geologists, botanists, zoologists, and archæologists, serves as a co-ordinating centre for the various efforts for Nature protection throughout Switzerland. Local sub-commissions have been appointed in all the Swiss Cantons, which suggest, for their respective Cantons, local laws for Nature protection. Already the Commission has secured the preservation of about 400 erratic blocks and 50 trees of special interest; further, some 13 moors, lake margins, bird sanctuaries and nesting-places have been

FIG. 1.—The Scarl Pass near Schembrina; in the background Murtèra la Tamangur (2998 m. above sea-level). The wood consists of larch and *Pinus cembra*.

FIG. 2.—Piz Linard (3414 m. above sea-level), seen from Zernetz. (This mountain is not in the National Park, but one of the finest sights from the Park.)

declared protected areas. The chief work of the Commission, however, has been the creation of a Swiss National Park. After many attempts an area of about 140 sq. kilometres in the Ofen district of the Lower Engadine was secured (between the years 1909 and 1914) as a Complete Nature Reserve.

FIG. 3.—Timber line at Munt la Schera. (Larch and *Pinus cembra.*)

This district is peculiarly suitable for the purpose for the following reasons: Its mean elevation above sea-level is considerable, in consequence of which the snow line lies as high as 3000 metres and the alpine tree limit at 2300 metres. Alpine life, therefore, can be widely distributed within the area. In wildness and naturalness, as in loneliness and seclusion, it is scarcely surpassed anywhere in Switzerland. It is very sparsely populated, so that the prohibition of forestry and grazing operations involve but little hardship for its human inhabitants. It possesses extensive forests, of which the 2600 hectares of dense forest of the erect mountain pine (*Pinus montana*, var. *arborea*) deserve special mention. There are also magnificent forests of *Pinus cembra*, mixed woods of spruce and larch (*Picea excelsa* and *Larix europaea*), a peculiar mountain race of Scotch fir (*Pinus sylvestris*, var. *engadinensis*), and extensive areas occupied by the creeping mountain pine (*Pinus montana*, var. *prostrata*). In addition to the great abundance of conifers there is also a rich herbaceous flora, the great variety of geological substrata rendering possible the existence of both calcicole and calcifuge plants. The dividing line between the floras of the western and eastern alps passes through the region. In the National Park there is, therefore, a mingling of eastern and western forms, many eastern species occurring, so far as Switzerland is concerned, only in this district. Animal life, too, is abundant, chamois, marmots, deer, foxes, black game, golden eagles, etc., enlivening the landscape.

The greater part of the National Park is leased by the State from the owners of the land for a period of ninety-nine years, the State alone having the power to terminate the contract. The State has further pledged itself to contribute a sum not exceeding 30,000 francs per annum for the rent of the Park. Human interference is absolutely excluded from the whole region. Hunting, fishing, manuring, grazing, mowing and wood-cutting are entirely prohibited. No flower or twig may be plucked, no animal killed and no stone removed; even the fallen trees must remain untouched. In this way absolute protection is secured for scenery, plants, and animals; Nature alone is dominant. Any one may visit the Park, but only simple alpine shelter huts are provided—no hotels are allowed to be erected. Camping and the lighting of fires are prohibited. The custodianship of the Park is entrusted to four resident keepers.

FIG. 4.—Alp la Schera with Munt la Schera (2588 m. above sea-level).

The Schweizerische Naturforschende Gesellschaft has undertaken to carry out a thorough scientific investigation of the National Park, and its Scientific Park Committee is now engaged on this work. The initial task is the preparation of complete lists of species inhabiting the reserve. Further, by means of exact surveys of selected areas, repeated from time to time, it is hoped to study—as the previous influence of man

and his domestic animals becomes more remote—the gradual restoration of the original flora and fauna, the re-conquest of pasture by forest, and so on. By the work of successive generations of investigators, it will be possible to follow the truly natural successions and changes occurring within the area, and to study in detail the natural relations between soil, climate, and organisms. The safeguarding from interference by man and beast will also be utilised to study the slow secular changes of land and water. In this unique laboratory, the naturalists of Switzerland will find themselves united in a common work. Maintenance expenses, such as the wages of the four park keepers and the upkeep of roads and huts, as well as the cost of the scientific investigations, are provided by the Schweizerische Bund für Naturschutz, an association which at the present time numbers more than 30,000 members.[2] Thus the Swiss National Park is a commonwealth in which alpine Nature can recover and develop undisturbed: a refuge, a sanctuary for plant and animal life. It is an island of primeval Nature, unaffected by the devastating waves of human civilisation which break about its shores. During visits to this Nature reserve one cannot fail to be impressed by the grandeur of the scenery and the wealth of plant and animal life. But still deeper is the feeling of patriotic pride that a whole nation is pledged to preserve this fragment of primitive Helvetia, unexploited for purposes of material gain, as a heritage for generations yet unborn. It is a piece of idealism especially valuable in this materialistic world.

[2] The annual membership subscription is 2 francs, life membership 50 francs. Foreign members are welcomed; any one wishing to join is invited to communicate with Dr. St. Brunies, Sekretär des Naturschutzbundes, Basel, Oberalpstrasse 11.

Obituary.

Dr. E. F. Bashford, O.B.E.

An outstanding figure in cancer research has been removed by the death, from heart failure, of Dr. Ernest Francis Bashford. After a most distinguished medical career at the University of Edinburgh, he pursued laboratory investigations in Germany, especially under Ehrlich, and became assistant to Sir Thomas Fraser in pharmacology. Even in the short time he spent in that laboratory, he enriched pharmacology by a memorable contribution on the antagonism of atropine and morphine.

When the organisation now known as the Imperial Cancer Research Fund was started in 1902, the committee appointed Bashford as general superintendent and director of the laboratories. So well was the confidence of the committee justified that in a few years his researches were known all over the world, and the laboratory, housed originally in the upper floors of the College of Surgeons' hall on Victoria Embankment, was recognised by all as the leading institute in the world for the experimental study of cancer. The position achieved was the outcome of intense work by a brilliant staff of colleagues inspired and directed by a forceful, imaginative, and tireless personality. The memorandum of proposed research submitted to the committee by Bashford at the commencement is still on record and demonstrates how surprisingly he, a young man with little previous acquaintance with the problems and quite inexperienced in the responsibilities of an institute, had grasped the essential fact that cancer must be studied as a problem in comparative biology. The exact statistical investigations of cancer in human beings in Great Britain and the collection of reports of its occurrence in civilised and uncivilised races early occupied his attention, and his writings proved convincingly that the incidence of the disease could not be correlated with many of the factors that impressed, and still impress, the imagination of the uninitiated. When there was added to this the study of the zoological distribution of cancer, the insistence on the breadth of the problem became obvious.

The first real advance in the biological study originated from the discovery by Jensen of the transplantability of a mouse carcinoma. The avenues thus opened up were enthusiastically explored, and there followed in rapid succession contributions dealing with the cytology of malignant new growths, the source of their cellular constituents, the specific reactions of the host, the induction of artificial resistance to growths, the study of refractoriness or susceptibility, the demonstration of the essential similarity of malignant neoplasms throughout the animal kingdom, biochemical investigations of great importance, and a host of other observations over the whole field which may be found in the first five Scientific Reports of the Imperial Cancer Research Fund published under Bashford's direction. Ill-health compelled him to resign his appointment in 1914. During the War he served in the Army in France as a pathologist, and was at the time of his death adviser in pathology to the British Forces on the Rhine. His work marks the beginning of the era of the scientific study of cancer in Great Britain.

ARCHIBALD LEITCH.

Lord Morley, O.M., F.R.S.

Lord Morley, whose death on September 23, at eighty-four years of age, we regret to record, was a great statesman and intellectual leader, the memory of whose work and noble character will long be cherished. As a writer on literary, historical, and biographical subjects, he covered a wide field in a style at once delightful and stimulating, and in the field of public life he preserved the best traditions of sincerity and truth. Though Lord Morley was not directly concerned with scientific research, he was sympathetic towards it, and was elected a fellow of the Royal Society in 1892 under the rule which permits the Council to nominate for election persons who "either have rendered conspicuous service to the cause of science, or are such that their election would be of signal benefit to the Society." He was a trustee of the British Museum, 1894–1921, chancellor of the University of Manchester from 1908 until last March, and one of the first members of the Order of Merit created by King Edward VII. in 1902. Lord Morley was made an honorary LL.D. of the Universities of Glasgow, 1879, Cambridge, 1892, St. Andrews, 1902, and Edinburgh, 1904, and an honorary D.C.L. of Oxford in 1896.

Lady Shaw.

Deep sympathy will be felt by a large section of the scientific world at the bereavement which Sir Napier Shaw has suffered by the death on September 22 of his wife, Lady Shaw, who was well known in scientific circles. Lady Shaw was for some time lecturer in mathematics at Newnham College, Cambridge, and was the author of an original little book entitled "First Lessons in Observational Geometry," published by Messrs. Longmans, Green and Co. in 1904. In this book, a course of observational and experimental geometry was outlined similar to that afterwards adopted in schools on the recommendations of committees on geometry as the best introduction to the formal study of the subject. Lady Shaw took a very active part in many organisations and institutions concerned with education, science, and progressive development generally. She was a member of council of Queen's College, London, and of the Women's Local Government Society. She served on several committees of the British Association, and was the secretary of the Citizenship Committee which has prepared and issued some valuable reports. Lady Shaw was also a member of Council, the Executive Committee, the Education Committee, and the Health Committee of the British Science Guild, and the members of these bodies, as well as all others associated with her, hold her memory in grateful remembrance.

Prof. W. Roser.

Prof. Dr. Wilhelm Roser, one of the directors of the Farbwerke vorm. Meister Lucius und Bruening in Hoechst-on-Main, died at Frankfort-on-Main on May 20. He was an important contributor to the development of the German industry of pharmaceutic products and coal-tar dyestuffs.

Prof. Roser came from an old-known Swabian family; his father, Prof. W. F. Roser, was an eminent surgeon of the University of Marburg, and there W. Roser was born on January 30, 1858. At this University he first studied mathematics, a science to which he devoted his hours of leisure. Afterwards he changed over to the study of chemistry under the guidance of Zincke. After a short stay with Fittig in Tübingen, he returned to Marburg and received his doctorate in 1882 for a research upon terebinic acid. For his studies regarding phthalyl-derivatives he received the *venia legendi* in 1885, and researches concerning pyridine and quinoline derivatives enabled him to clear up the constitution of narcotine, an opium alkaloid.

After his nomination as a professor in 1892, the Hoechst firm engaged Prof. Roser as director of the scientific department of their works, at a time when the German chemical factories, having successfully produced acetanilide, phenacetine and antipyrine, were devoting themselves to the further investigation and production of medicines. Prof. Roser was able to direct this work with success. He took part in the elucidation of the constitution of adrenaline and in the synthesis of rivanol, while in the dyestuff branch he was also very successful. It was his main task to introduce young chemists who had come from the High Schools into the works, to the way of working and thinking necessary for technical practice. Several generations of technical chemists owe him their education. He himself was a taciturn man of keen observation and wide knowledge, highly esteemed by industrial chemists as well as by men of science.

We regret to announce the following deaths:

Mr. Malcolm Fraser, late Registrar-General and Government Statistician of Western Australia, on September 17, aged sixty-six.

Dr. F. J. H. Jenkinson, since 1889 Librarian of the University Library, Cambridge, on September 21, aged seventy.

Prof. R. Pumpelly, formerly professor of mining geology at Harvard University, and for many years on the United States Geological Survey, on August 10, aged eighty-five.

Current Topics and Events.

It would appear that the protests which have appeared in the *Times* and elsewhere against the proposed erection of a wireless station at Avebury have been successful. Sir Charles Oman in his presidential address to the Gloucestershire Archæological Society, as reported in the *Times* of September 14, announced that he had received a letter from Sir L. Worthington Evans, the Postmaster-General, stating that the proposal would probably be dropped. Recent experience has made it clear that existing legislation for the protection of sites of archæological importance is inadequate, while it affords no guarantee in the case of any site which is not scheduled under the Protection of Ancient Monuments Act. In the present instance, it is peculiarly disturbing that Government Departments were concerned in what can only be described as an act of vandalism. During the recent meeting of the British Association at Liverpool, reference was made to this matter on more than one occasion, and before the Association dispersed, a resolution was passed which, while instancing the cases of Holmbury Hill, Avebury, and Lulworth Cove, urged strongly in general terms the extension of the powers which may be exercised in the protection of sites of natural beauty or archæological interest.

The use of pulverised coal is spreading steadily, and at the present time more than 20,000,000 tons per annum is being burnt in the United States and Canada alone, largely in the cement, iron and steel, and glass industries. Also the use of coal in a fine state of division is being considered in connexion with the manufacture of briquettes, low-temperature carbonisation, and total gasification processes, such as producer gas. The most striking progress, however, during the last three or four years has been in the use of pulverised coal for steam generation. Since 1920 some of the largest and the most important power stations in the world have adopted this method

of firing, and we understand that to-day more than 1,000,000 tons per annum is being burnt under steam boilers on the "Lopulco" system, while in the next few months, as soon as plants now in course of erection or conversion are completed, the figure will exceed 2,500,000 tons. The pioneer large boiler plant installation for pulverised fuel is the "Lakeside" station of the Milwaukee Electric Railway and Light Co. on Lake Michigan, 40,000 kw. of which was started up in December 1920. This boiler plant is held to be the most efficient in the world, running all the year round at 85-86 per cent. efficiency. The first large pulverised fuel boiler plant in Europe is now being erected at the Vitry power station, Paris.

JUST forty years ago, on September 29, 1883, Prof. Dr. Carl Duisberg entered the employment of the Farbenfabriken Bayer and Co. in Elberfeld, and the influence he has exerted upon the development of the German industry of coal-tar dyestuffs and pharmaceutical products has made his name renowned throughout the world of applied chemistry. Prof. Duisberg received his doctorate at Jena; he then went to Munich in order to complete his education under Adolf von Baeyer, and at that time laid the foundation of the great friendship which for the future connected him with that eminent chemist and with a large number of his pupils. Shortly after he entered the Farbenfabriken, and succeeded in making essential improvements in the manufacture of substantive cotton dyestuffs. He thereupon became the head of the firm's scientific laboratory, in which he mainly endeavoured to put the purely chemical work on a broader basis than heretofore. At the same time he began to organise the whole business, first by dividing the work of the chemists according to the different kinds and classes of dyestuffs, etc., and then by uniting in one working concern the four principal German firms which make direct cotton dyestuffs. This was the first step in the formation, later on, of the "I.G.," the large concern of German coal-tar dye makers. The site of the works in the narrow Wupper valley of Elberfeld having become insufficient for the rapidly increasing manufacture, it was resolved to build large modern works, and under Prof. Duisberg's direction a magnificent plant was erected at Leverkusen, near Cologne. During the War, after some years of keen competition, the remaining dye-making firms joined this first amalgamation, chiefly through Prof. Duisberg's influence, thus forming one large combine in which the firms preserve their individualities but, at the same time, all proceedings are directed by a uniform programme, and each firm partakes of the profits of the whole concern according to its share in the work. In addition to his activities at the Farbenfabriken, Prof. Duisberg is well known by many other achievements in chemistry, while his great versatility is manifest from the volume containing his essays and speeches published by the Farbenfabriken on the occasion of his jubilee.

THE intellectual stimulus to China of the revolution of 1911 is still manifest by increased scientific and intellectual activity. Despite the political disturbances of the last two years, the scientific institutions are growing in number and usefulness. The Geological Society of China was founded last year, and held its first annual meeting at Pekin in January under the presidency of Dr. V. K. Ting. This year has also seen the establishment of "the China Society of Science and Arts," of which the *China Journal of Science and Arts* is the official organ. It is also the journal of the Shanghai Chemical Society. The fourth number, issued in Shanghai in July (price 2 dollars, pp. 303-424), edited by Mr. A. de C. Sowerby and Dr. J. C. Ferguson, includes an interesting series of papers and notes on scientific and artistic work in China. The articles deal with the Chinese fisheries of Amphioxus, which in places is a food-fish; the Chinese "Mudskipper," *Periophthalmus cantonensis*, which Mr. Sowerby suggests is not merely in the process of evolution to a terrestrial life but may give rise to a race that may replace the higher vertebrates; "The Dragon Mines," by Dr. J. Gunnar Andersson, who describes the ancient Chinese excavations for fossil vertebrates for use as medicine, and also the recent research on Chinese vertebrate palæontology; the war on insect pests, and on the rôle of bacteria; ancient Chinese coins, by E. F. S. Newan; Chinese female names, by J. C. Arlington; Chinese landscape gardening, by Miss Ayscough; a recent exhibition of Chinese pictures; a journey to the Yangtze gorges for photographic work, by H. F. Carey; the dissociation of prehnite, zoisite, and epidote, by E. Norin; the conditions of the Chinese soap manufacture, by Mr. Hsu; and the aborigines of Western China. There are also various reviews and notices of the work of the Chinese scientific societies. The Journal is well illustrated, and deserves the support of all interested in China, as it gives a useful general review of scientific, artistic, and literary work in and in connexion with China.

SIR HUMPHRY ROLLESTON will deliver an inaugural address on "The Problem of Success for Medical Women" at the London (Royal Free Hospital) School of Medicine for Women on October 1, at 3.30 P.M.

THE Research Association of British Flour Millers has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the government scheme for the encouragement of industrial research. The secretary of this Association is Mr. G. H. Ball, 40 Trinity Square, E.C.

THE *British Medical Journal* announces that the Canadian Medical Association is arranging for a Lister Oration to be given once every three years. The first of these will be given next year at the annual meeting in Ottawa by Dr. John Stewart, of Halifax. Dr. Stewart was one of Lister's house-surgeons in the early days of the latter's work in Edinburgh.

ACCORDING to the New York correspondent of the *Times*, a number of fires broke out in many counties of California on September 17, one of which spread to the residential district of Berkeley. Some six

hundred houses were destroyed, including the residence of Dr. B. I. Wheeler, president-emeritus of Berkeley University, but all the buildings of the University itself were saved. The damage is estimated at 2,200,000*l*.

The Institution of Petroleum Technologists is now installed in its new offices at Aldine House, Bedford Street, Strand, London, W.C.2. In addition to a general office, council room, and a well-appointed library, a large room has been fitted up as a members' room. As a house-warming for the new offices, the president and council will receive members and their friends on Wednesday evening, October 3, from 8 to 10 p.m. During the evening scientific apparatus will be exhibited and demonstrated. Admission is by ticket only.

The lectures on recent excavations given during the summer by Miss Claire Gaudet will be repeated this winter on Thursdays, commencing October 4, at the British Museum. The subject, as before, will begin with the earliest known civilisation as shown by the discoveries made within the last few years in Mesopotamia, and will include the excavations at Ur and this year's work at Kish, now known to have been the capital of the first Empire in the world's history, and said to date from about 5000 b.c. The evolution of architecture from these early times until the Roman and early Christian periods, showing the classical influence on all subsequent art up to the present day, will form the basis of the lectures, including whenever possible the arts and crafts of the people. Further particulars may be obtained from the Hon. Secretary, 120 Cheyne Walk, Chelsea.

Sir Arthur Keith, in his annual report on the museum of the Royal College of Surgeons, refers to the completion of the series of exhibits illustrating the principles of pathology. In 1910, Prof. Shattock and Mr. Cecil Beadles commenced to select, arrange, and catalogue specimens. The War interfered with this work; but six further stands were interpolated this year with the noteworthy result that, for the first time, "a complete and systematic treatise on disease has been written, not in words, but in illustrative specimens," and the scope of the pathological section is regarded as fixed. Mr. Cecil Beadles is now in charge of the National War Collection, which will soon be arranged in accordance with an approved scheme. The president of the Royal College of Surgeons of Edinburgh has been given leave to make a selection from War specimens left in store, for the museum of his college. Among notable additions made to the Museum during the past year are a cast of the tooth held by Dr. H. F. Osborn to indicate the existence of a human genus, Hesperopithecus, in N. America during the Pliocene period; a skeleton, probably of Anglo-Saxon date, showing evidence of infantile paralysis, "the earliest trace of this disorder in England"; and the late Celtic remains found at Wortley, Hants, presented by Mr. R. W. Hooley.

Porto Santo, the northern island of the Madeira Archipelago, has a population of nearly three thousand, and the inhabitants have the reputation of being free from dental caries. Dr. M. C. Grabham visited the island recently and examined six hundred natives, twenty-eight of whom were found to be cases of well-established caries. All except seven of these people, however, came from Madeira, and only two of the seven showed the sign which characterises the Porto Santo dentition and is associated with immunity from caries. Early in life, natives of the island develop this characteristic, which consists of a slight yellow band on the upper incisors, and whenever this yellow stain is present, a sound set of teeth accompanies it. The line or band occurs and develops with a regularity which gives evidence of the permeation of the blood fluids in the interstices of the columnar enamel and is associated with an influence protective against the access of caries. Both the stain and the protective influence appear to be derived from the highly mineralised water of the island, the springs of which are rich in chlorides, carbonates and sulphates, in contrast with the sweet waters of Madeira. Dr. Grabham found no scurvy on the island, but many cases of pulmonary disorder. Diarrhœa and alimentary ailments were singularly absent, and the mineralised waters seemed inimical to intestinal parasites. There was no existing instance of malignant disease. Traditionally some cases have occurred, but no form of cancer has taken root at Porto Santo, and Dr. Grabham is inclined to associate this exemption with the simple feeding of the people and with the absence of animal fats, except lard, from the food, and lard is known to be deficient in the vitamin necessary to promote growth and prevent rickets. Food is taken cold; there is no milk or green vegetables, and nothing to involve grinding mastication. The main sustenance is derived from maize boiled with a modicum of lard, with the occasional addition of fish and an onion or two. At the Liverpool meeting of the British Association, where Dr. Grabham described the results of his inquiry, he showed a skull (since deposited in the Hunterian Museum) of a Porto Santo man of about sixty years of age, taken promiscuously from an exposed grave, whose teeth were all sound: and also exhibited many specimens of the soil, the vegetation, and the mineral water with analyses.

Among the forthcoming books announced by the Old Westminster Press is the 3rd edition of "Popular Fallacies" by A. S. E. Ackermann, which contains 696 pp. of new matter, and deals with 1350 fallacies, including the 460 of the 2nd edition.

The Oxford University Press will publish shortly an original work, by Mr. R. T. Gunther, on the instruments used by early men of science, under the title "Early Science in Oxford." The work will be issued in two volumes—one on chemistry, mathematics, physics and surveying, and the other on astronomy. No university is richer in the apparatus and records of bygone men of science than Oxford. Mr. Gunther's illustrated account of her early science is the outcome of a first attempt to direct attention

to those instruments, and to early descriptions of instruments, by which scientific studies in the university have been advanced.

DR. D. H. SCOTT is bringing out through Messrs. Macmillan and Co., Ltd., "Extinct Plants and Problems of Evolution," a volume founded on a special course of lectures given in 1922 at the University College of Wales, Aberystwyth, the object being to sketch, in broad outline, the geological history of the plant-kingdom, in its bearing on the theory of descent. Messrs. Macmillan also announce "Life in Southern Nigeria: The Magic, Beliefs, and Customs of the Ibibio Tribe," by Amaury Talbot, Resident, Nigeria; vol. iii. (Mammalia) of Prof. von Zittel's "Text-book of Palæontology," revised by Dr. Max Schlosser, translated under the direction of the late Dr. C. R. Eastman, by Marguerite L. Engler and Lucy P. Bush, and revised by Dr. A. Smith Woodward; and a new and revised edition of Prof. W. J. Sollas's "Ancient Hunters."

Errata:—In the article on "The Earth's Magnetic Field for 1922," by Dr. Louis A. Bauer, in our issue of August 25, the formula on p. 295 should be given the number (1); the second author mentioned in the fourth paragraph, third line, p. 296, should be Mr. H. Furner instead of Prof. H. H. Turner.

Our Astronomical Column.

THE SOLAR ECLIPSE OF 1922 AND EINSTEIN'S THEORY.—The current number of the Lick Observatory Bulletin, No. 346, contains the results of the observations on the deflexion of light in passing through the sun's gravitational field made during the total solar eclipse of September 21, 1922, at Wallal, Western Australia. The authors, Prof. W. W. Campbell and Mr. R. Trumpler, give all details for this particular research, which represents only a part of the programme of the William H. Crocker Eclipse Expedition from the Lick Observatory. Two very interesting diagrams show at a glance the type of the results obtained. The first of these is a star chart of the neighbourhood of the eclipsed sun containing the 92 stars actually measured for the investigation. The observed relative displacements of the stars are indicated by short lines oriented according to the directions of displacements. The outline of the brighter parts of the corona as well as the limit of the faintest traces of coronal light are indicated. The second instructive diagram shows the observed radial displacements for each star as a function of the star's angular distance from the sun's centre, while for comparison sake a curve is given indicating the values predicted by Einstein's theory. This graphical representation demonstrates the coincidence between the observed and the predicted light deflexions. By arranging the stars in groups according to their distance from the sun's centre the observed relative radial displacements can be seen from the accompanying table.

Group.	No. of Stars.	Weight.	Mean Dist. from Sun.	Obs. Rad. Displ.	Theoretical Rad. Displ.
			°	"	"
1	8	9·09	0·64	+0·64	+0·70
2	11	19·42	1·06	+0·35	+0·37
3	10	20·15	1·40	+0·30	+0·24
4	8	22·41	1·66	+0·16	+0·17
5	9	21·10	1·90	+0·17	+0·13
6	8	24·67	2·00	+0·15	+0·11
7	11	21·32	2·22	+0·08	+0·08
8	13	21·37	2·55	−0·09	+0·02
9	14	22·78	2·97	−0·04	−0·03

It will be noted that the observed radial displacements given in this table are in remarkably good agreement with the values predicted on the basis of Einstein's theory. The authors point out also that even the stars between 1·25° and 2·25° from the sun's centre, which lie entirely outside of any trace of the corona, show the light deflexion well marked, an effect that would be difficult to explain by an extended solar atmosphere.

EPHEMERIDES OF ALGOL VARIABLE STARS.—At the meeting in Rome of the International Astronomical Union in 1922, the representatives of the Cracow Observatory undertook the calculation and publication of these ephemerides. No. 1, containing these calculations for the second half of 1923, has lately come to hand, edited by Th. Banachiewicz. The explanatory matter is printed both in Polish and in Peano's flexionless Latin, the latter being easy to read.

Comment is made on the fact that from the date January 1, 1925, the astronomical day will begin at midnight, which will cause a break of continuity in formulæ that use the Julian day (beginning at noon). To avoid confusion, it is suggested that a new cycle of days be employed for this purpose, the zero date being the midnight at the beginning of January 0, 1801 (Greenwich). This is adopted in the present work, and tables are given to reduce calendar dates to it. Tables are given for 31 stars, including Algol, the adopted elements being corrected by recent observations, made in several cases by J. Gadomski at Cracow. The times of minimum are given to the third decimal of a day (about 1½ minute).

Since all the minima occurring on each day are arranged on the same page and in the same line, it is a very simple matter to draw up a programme of work on any given night.

FURTHER SEARCH FOR INTRA-MERCURIAL PLANETS.—Though we know from the presence of the Zodiacal Light that there is a considerable amount of scattered matter inside the orbit of Mercury, it becomes more and more unlikely with each total eclipse that there is any single body of sufficient size to be separately discerned or photographed. Prof. Campbell and Mr. Trumpler have made a careful search on the large plates (17 inches square) taken for the Einstein problem in the eclipse of September 1922. They embrace an area of 15° × 15°, and show 550 stars, the faintest being of magnitude 10·2. They were compared, star by star, with the comparison plates taken in Tahiti four months earlier. Nothing was detected in the search; it is noted that rapid motion might weaken a planet's image, but, allowing for this, there could not have been any planet as bright as magnitude 8·5 in the region of the plates, unless it was in the denser parts of the corona. Perrine's search in 1908 covered a region 25° × 8½°, but did not reach quite such faint stars as the present series.

Research Items.

MAGLEMOSE CULTURE IN EAST YORKSHIRE.—The discovery of the Maglemose harpoon at the lacustrine deposits at Skipsea has led Mr. A. Leslie Armstrong to examine, in search of further examples of Maglemose culture in Yorkshire, the strata exposed by recent erosion on the Holderness coast. In the September issue of *Man* he describes a number of flint implements found in the course of his exploration. He remarks that " it is significant that when placed side by side with a series of the usual East Yorks artifacts from the surface, these deeply stained examples from the silt and peat beds are as distinctive therefrom in type as they are in patination, and that they can be paralleled in both patina and type only by certain implements of a dark brown and highly lustrous patina found upon one or two restricted areas in the vicinity of Skipsea and Atwick, upon elevated ground, which there is reason to believe represent former islands in the ancient marshland and sites of early occupation."

NEOLITHIC MAN IN PATAGONIA.—In " Habitantes Neoliticos del Lago Buenos Aires " (*Revista del Museo de La Plata*, xxvii. pp. 85-160), Dr. José Imbelloni describes human remains from Lago Buenos Aires—a place far away in the south-west of Patagonia, which must not be confused with the town of Buenos Aires. It would appear that the number of prehistoric skeletons found in Patagonia diminishes rapidly from north to south. The description, therefore, of a number of finds near Lago Buenos Aires, in the south-west, is of special importance. The ten skulls described were found so long ago as 1897 by Dr. S. Roth under constructions called *chenques*—erections consisting of stones heaped over the bodies more or less symmetrically without there being any form of dug graves. A number of these *chenques* occur in the region of the lake in question. Their age is stated to be Neolithic, though the only proof appears to be the absence of metal (other than precious) from the funeral furniture associated with the burial. Neolithic culture it may be, but of what date in time? To the student of the physical structure of the early inhabitants of this part of the world Dr. Imbelloni's brochure will be of interest, for a long and detailed description of the skulls is given. Comparisons with similar remains from further north are also included. Mention is made of some of the prehistoric skulls of the Old World, but, though interesting, it is to be doubted if any real correlation between types and even cultures of the New and Old Worlds is ever really likely to be fruitful.

SURVEYS IN GREENLAND.—The work of the Danish bicentenary expedition to North Greenland under Mr. Lange Koch included important explorations in Peary Land. Some account of this work with preliminary maps appears in an article in the *Geographical Journal* for August. The expedition filled in the surveys of the north coast between De Long Fjord and Cape Bridgman, thus practically completing the general survey of the coasts of Greenland. On the return journey the southern part of Peary Land was explored and surveyed, and the problem of the so-called Peary Channel reported by the late Admiral Peary in 1892 was finally solved. Erichsen in 1907 found that the channel as a seaway did not exist, but Mr. Koch has now discovered the reason of Peary's mistake. The course of the " channel " between J. P. Koch Fjord and Bronland Fjord is occupied by a long low valley, the flow of which is about 200 metres above sea level. Wandel valley, as it is named, separates Peary Land from the rest of Greenland. Peary Land is thus virtually an island, and probably during the period of greatest glacial subsidence in the past was entirely separate. It consists of a northern mountain mass of two parallel chains each rising to above 2000 metres and a southern plateau nowhere over 1000 metres. This plateau is low in the east and higher in the west. Local glaciers fill many of the valleys. The expedition also did important surveys in Wulff Land at the head of Sherard Osborn Fjord and in Washington Land, east of Kennedy channel.

EARTHQUAKE IN THE BAY OF CHIJIWA.—The Journal of the Meteorological Society of Japan for January contains an article by Mr. Saemontaro Nakamura on the earthquake which occurred near Nagasaki on December 8, 1922, when 27 persons were killed, 11 were injured, and 182 houses were destroyed. Microseismic observations at several stations, the directions and durations of the earth-sound in the epicentral region, and the direction and intensity of the shocks, indicate an epicentre in the Bay of Chijiwa. It had the typical tectonic characteristics with regard to the time of distribution of after-shocks, and the distribution of the direction of the first movement at stations about the epicentre. The axis of the dislocation deduced by the first movement coincides with a geographical, or geological feature of the locality. It caused no changes on Mt. Unzen, an active volcano quite near the epicentre of the earthquake. It may be supposed that this earthquake has no direct relation with the volcanic eruption of Mt. Unzen. The locality affected is situated about 500 miles to the west-south-west of the recent intense earthquake which involved Tokyo, Yokohama and the surrounding country.

WEATHER IN CANADA.—The meteorological service of the Dominion of Canada publishes regularly a monthly Weather Map, and the map for July last has recently reached us. Observations of air temperature and rainfall are shown for the several meteorological stations comprised in the chart. The differences of temperature from the normal are indicated by lines, much as we show isotherms. Rainfall amounts are shown by a varying degree of shading. July temperatures were higher than normal over most of the interior of British Columbia, in Alberta, Saskatchewan, Manitoba, and Kenora, Rainy River and Thunder Bay regions of Ontario. From the eastern end of Lake Superior to the Atlantic Ocean they were below normal. The greatest excess of temperature, about 8°, occurred in Manitoba, and the greatest defect, about 6°, in northern New Brunswick. Precipitation over the greater part of the wheat region of the Western Provinces ranged from three to seven inches. Coupled with the meteorological notes, the conditions of crops and fruit are shown for the different parts of the Dominion.

SALT-MARSH MOSQUITOES.—The valuable work of Mr. J. F. Marshall and his associates on the Hayling Mosquito Control has already been commented upon in these columns (NATURE, August 19, 1922, p. 261) in reviewing the first report of that body. Since then steady progress has been made, as instanced in the second report (issued in May last) and in a recent article and letter in the *Field*. For any success in mosquito control work it is essential to arouse public interest and co-operation, and Mr. Marshall has succeeded in doing this at Hayling Island. Further, it is satisfactory to learn that the example of Hayling has already been copied by Gosport, where a similar local " control " has been organised under the

energetic direction of Surgeon-Commander D. H. C. Given. In the words of Mr. Marshall, "Both in Hayling and Gosport the mosquito nuisance has already decreased by an almost unbelievable extent." This satisfactory result is largely due to the preliminary biological investigations. These showed, first, that practically the whole of the nuisance was due to one particular species, *Ochlerotatus detritus*. Not only was it found that this species far outnumbered all the others put together (in the proportion, it is said, of not less than 1000 to 1), but also it was found that the domestic *Culex pipiens*, present in fair numbers, was not addicted to sucking human blood. In the second place, the very important discovery was made that *O. detritus* will only breed in more or less salt water which is allowed to stagnate. The control of this species is therefore largely a matter of ensuring that no salt water is allowed to become cut off from tidal action, and by united effort this can be done in any of the coastal towns where this particular species is the chief offender against the comfort of the inhabitants. Such work must, however, cover a considerable area, for *O. detritus* has been found to spread at least four miles from its breeding-grounds. The experiences at Hayling should prove valuable in any attempts which are made in the control of our second salt-marsh species, *Ochlerotatus caspius*, which is now known to be the chief cause of the mosquito nuisance in the London area, as well as at some East Coast resorts. In this case, however, the problem is complicated by two difficulties: in the first place, *O. caspius* does not breed *exclusively* in salt water, and, secondly, its range of flight appears to be much greater than that of *O. detritus*. It can scarcely be doubted, however, that a much closer study of the distribution and biology of *O. caspius* would reveal facts of which practical use could be made in reducing its numbers. The prime importance of such biological work has been well illustrated at Hayling.

CAINOZOIC AND RECENT AUSTRAL RHYNCHONELLIDS.—In NATURE, vol. 110, p. 262, 1922, the fate that has overtaken the genera Terebratula and Rhynchonella, mostly under the penetrating eye of Mr. S. S. Buckman, was mournfully recorded. Mr. F. Chapman (Proc. Roy. Soc. Victoria, vol. 35, p. 175, 1923) now finds that Hutton's *Rhynchonella squamosa* must become the genotype of a new genus (here called by a misprint "sp. nov."), which he names Tegulorhynchia. A critical description, with figures and a bibliography, is given of the Cainozoic and recent rhynchonellids of the austral region.

HARD X-RAY TUBES.—In the issue of *Die Wissenschaften* for September 7, Prof. Knipping, of Heidelberg, gives a summary of his work on the cause of the inability to transmit electric current which is found in X-ray tubes after they have been in use for some time, even when the pressure of the residual gas in them is raised to 0·01 mm. of mercury by the regenerative arrangement with which they are generally provided. He finds that the effect is due to the absence of positive nuclei of hydrogen atoms which are necessary to render any gas at low pressure conducting. In their absence a gas at the above pressure behaves towards the passage of electricity like a perfect vacuum, and the author speaks of such a gas as a pseudo high vacuum. In normal circumstances the hydrogen nuclei are provided by the moisture which is condensed on the walls of vacuum tubes, and continued use of the tubes exhausts this supply. Prof. Knipping is continuing his investigation, and points out that the present theory of the emission of electrons from heated bodies requires modification to include the effect of the surrounding medium.

COLLOIDAL PROPERTIES OF RICE STARCH.—It is well known that the granules of starches vary not only in their appearance according to their origin but also in their properties; thus sago, tapioca, and cassava starches yield more glutinous sols than others. This difference is well marked between the common and glutinous rice starches, and Messrs. T. Tadokoro and S. Sato have made this the subject of an interesting paper in the Journal of the College of Agriculture, Hokkaido Imperial University (1923, vol. 13, p. 1-65). These authors show that there is a difference in the behaviour of the two kinds of granules towards iodine, and both in suspension and in dilution the affinity of glutinous starch for iodine was less than that of ordinary starch. Coagulation of the solutions by the addition of alcoholic hydrochloric acid or by solutions of metallic salts was obtained more readily with ordinary starch. The colloidal properties as shown by the hydrating power, water retention, viscosity and protective action (gold value) of the strong solutions was greater in the case of glutinous starch, thus indicating the greater dispersion of this substance in solution. In the formation of a jelly by the addition of tannin solution, a greater quantity of the reagent was required for the glutinous starch, and the ultramicroscopic appearance of the gel resembled a network instead of a foam as shown by the gel of ordinary starch. Further differences were shown by the two varieties of starch with regard to the decomposition of the blue iodine compounds by X-rays and various reagents, and the adsorbent power of charcoals derived from the starches by ignition. In spite of the many differences in colloidal behaviour of these two starches, there was no noticeable variation in their ordinary chemical properties. The observed differences are attributed to a different degree of polymerisation between the starches.

LIQUID FUELS IN AUSTRALIA.—The Australian Commonwealth Institute of Science and Industry has issued a bulletin (No. 24) compiled by R. E. Thwaites on "The Production of Liquid Fuels from Oil Shale, and Coal in Australia." The main part of the bulletin is occupied with a survey of mineral oil supply viewed as a world problem. It gives an interesting and comprehensive review, both technical and economic, together with speculations as to the future sources of liquid fuel. The problem is then analysed as it bears upon Australia itself. There the conditions seem to resemble those of Western Europe. Proved deposits of mineral oil are scanty or non-existent. Home produced liquid fuel will have to be derived from oil shales, lignites, and bituminous coal, of which considerable deposits are now exploited or known. The oil shales though rich are limited in quantity and an existing industry engaged in their distillation is at a standstill, rendered unremunerative for the moment by high working costs. The proved deposits of such shales would not, however, furnish Australian requirements at present rates of consumption for more than ten years. The supply in the future will have to be based on coal and brown coal both occurring abundantly. The existing towns' gas industry, carbonising coal at high temperatures, already makes a useful contribution of liquid fuel. The author looks for greater production in the future from this source and from developments of carbonisation at low temperatures. The technical and economic problems involved are recognised and a plea is advanced for the institution of a fuel research laboratory to explore the subject with special reference to Australian conditions.

Royal Photographic Society's Exhibition.

THE sixty-eighth annual exhibition of the Royal Photographic Society was opened on Saturday, September 15, at the Society's house, 35 Russell Square. It will remain open until October 27, and admission is free.

The scientific and technical section is, this year, divided into nine subsections, and it would have been a great improvement if this division had been maintained in the exhibition itself, for those interested in these matters prefer a clear classification to symmetrical hanging. There is a total absence of astronomical exhibits, and the exhibition is the poorer for it. Still, the space available, which is more than heretofore, is well filled with good and interesting work. Any one who delights in animals of all sizes, birds, insects, etc., will find a selection of work that probably has never been excelled. Of special interest is Mr. Oliver G. Pike's demonstration of the use of kinematography in his enlargement from a film showing in eight stages at half-second intervals a cuckoo approaching a meadow pipit's nest, taking out one of the eggs, laying its own egg, and flying off with the stolen egg, which it then eats.

The American Raylo Corporation illustrate Mr. H. C. J. Deek's three-colour process, which does for colour prints on paper what the introduction of gelatin plates did for ordinary negative making. It simplifies the operations and eliminates many of the difficulties. The three negatives are taken consecutively, side by side, on a small plate, but the changing of the screens and the shifting of the plate are done mechanically, and the total time occupied may be as short as one quarter of a second. Each record on the triple negative measures 1 in. × 1½ in. Development is done in a metal box, no dark room being necessary. The final prints are 5 in. × 7 in. The negative is enlarged upon a sheet which has upon it side by side the necessary red, yellow, and blue pigmented and sensitised gelatin films, each on a thin sheet of celluloid. It is developed in warm water, and the superposition of the three is done by means of a special adjusting frame, so that the accurate register is very easily secured.

The radiographic prints exhibited are specially noteworthy. The human hand taken with an exposure of one-twentieth of a second by Mr. A. A. Campbell Swinton is compared with the radiograph made by Mr. Campbell Swinton in 1896 (the first made in England) which required 20 minutes' exposure. Dr. Robert Knox shows, among others, radiographic records of the movement of the left border of the heart, in a normal condition and in a case of heart block. These are taken with a slit diaphragm and a moving film.

There is a considerable section of photomicrographs which includes examples of almost every possible kind. Mr. F. Martin-Duncan has prepared specimens of the hairs of the primates by a special mounting process and illuminated them in a special manner, so as to show the extremely delicate cuticular scales on the outer surface. These are of great importance as a certain means of identification and classification. Mr. J. H. Pledge shows a series which demonstrates the variation of stem structure in successive years of a twig of mistletoe.

Specimens of the use of the Low-Hilger Audiometer are shown by Prof. Low and also by Messrs. Hilger. These include the Melba trill, the Melba exercise for the cure of corns on the vocal chords, and sound wave records of several musical instruments.

The Royal Air Force has a series of photographs taken from aeroplanes, which demonstrate to what a wonderful degree of perfection this method of work has been developed. Two aeroplanes in collision at Northolt last June were photographed at the critical moment by Mr. G. V. Grundy. Mr. H. Roussilhe shows drawings of the apparatus used for the correction of aerial photographs and the production from them of plan maps, with specimens of the steps in the process.

Among the stereoscopic prints, lantern slides, and colour transparencies will be found many of excellent quality. The "Cine-Kodak" and the "Kodascope," which reduce the cost of taking "moving pictures" to one-fifth that of the standard apparatus, will be demonstrated at 11.30 A.M. and 3 P.M. each day. These machines have already been referred to in these pages (NATURE, September 1, p. 333).

The European Drought of 1921.

A LENGTHY discussion of diverse aspects of the great drought is afforded by Prof. Filippo Eredia in a paper entitled "La Siccità del 1921," published on the authority of the Ministry of Public Works, Rome, in 1922. Although the dry weather of that year appears to have affected in varying degrees practically the whole of Europe, and in conjunction with the political situation led to the terrible famine in Russia, the region dealt with in this communication is limited to Italy, Switzerland, France, and Britain, and for the last-named country the author avails himself of the material supplied by Messrs. Brooks and Glasspoole (Quart. Journ. Roy. Meteor. Soc., vol. 48, 1922).

In Ireland, and in Scotland except on the east coast, the rainfall of 1921 did not, as a rule, fall below 80 per cent. of the normal, and as over much of these two countries the normal amount is heavy, the deficiency of 20 per cent. did not mean any real condition of drought except, perhaps, for quite brief periods now and then during the course of the year. But in eastern and southern England, and the major portion of France, the total fall in 1921 only amounted to from 60 to 50 per cent. of a much lower average, so that the economic consequences of a deficiency equal to half the average were very serious. Locally in the extreme S.E. of England the rainfall of 1921 was less than 50 per cent. of the average, while in many places in southern and eastern France, Switzerland, and northern Italy it barely exceeded 40 per cent., *i.e.* a deficiency of nearly 60 per cent. In London the rainfall of the year was the lowest for at least 150 years, and was actually less than the evaporation—a very rare occurrence in the damp, cool climate of England. But whereas in England, France, and Switzerland the most intense phase of the drought coincided with the midsummer heat of June and July, in Italy the dearth of rain did not become acute before September, after which in northern or continental Italy there was practically no rain till the beginning of 1922, the month of October, normally the wettest in the year, being absolutely rainless at Milan and other places—a unique occurrence for that month.

In central and southern Italy, on the contrary, the deficiency of rainfall in the last three months of 1921 was less marked than in the north, while the normal summer Mediterranean drought of peninsular and

insular Italy was actually less rigorous than usual. In continental Italy the snowfall both in the mountains and plains during the early months of 1921 was very light, and this coupled with the almost entire absence of rain in the autumn caused the Alpine streams at the end of the year to fall lower than had ever been remembered. Perhaps the most interesting feature in the geographical distribution of the drought, as concerns the four countries named, is the general intensification from England in the N.W. to Italy in the S.E.—that is from a more oceanic to a more continental regimen of climate. (See article in Nature on "Climatic Continentality and Oceanity," April 21, p. 549.) It is known that both excesses and deficiencies of rainfall with respect to the average are normally more marked in continental than in maritime regions, and the reason is not difficult to understand when one reflects that rainfall is but a by-product of the circulation of the atmosphere and the changes of temperature, in the several strata, associated therewith. Hence, one would expect vicissitudes of rainfall to bear some relation to continentality, because all variations of temperature, seasonal, diurnal, or irregular, tend to be accentuated on land and damped out on sea.

In France and England the drought, which was essentially a summer one, commencing about February and terminating about November, was connected with a marked excess of barometric pressure over central Europe. There seems to be no doubt that the normal Mediterranean high pressure was in the summer of 1921 displaced northward, permitting secondary depressions to develop now and then over the Mediterranean Sea, with alleviation of the ordinary summer drought in that region as stated above. In England during the summer we were commonly located in the northern portion of the French anticyclone, with the usual westerly winds but without the usual moisture. More usually we lie farther towards the polar edge of the south-westerly winds, which are then associated with the convergent air-streams of barometric depressions; but evidence has been adduced ("British Rainfall, 1921") that in 1921 there was a greater preponderance of divergent air-currents.

It is important that students endeavouring to understand something of the origin of rainfall in England should co-ordinate the more distant point of view of the physical geographer who associates our rainfall with the abundant moisture supplied to the south-westerly winds by the warm Atlantic Drift, with the more immediate point of view of the meteorologist who relates it to the incidence of barometric depressions, that is, of convergent and ascending air. Students, too, accustomed to think of the proverbial dryness of east winds in Great Britain, are often greatly puzzled by the persistent rain we not infrequently experience with wind from that quarter. There is no discrepancy, however; for in many cases of rain with east wind on the northern side of a depression, the moisture is supplied by an Atlantic current above the drier easterly current through which the rain is falling.

L. C. W. Bonacina.

University and Educational Intelligence.

London.—An attractive series of free public lectures during the Michaelmas term has been arranged at King's College. Prof. A. Dendy is giving nine lectures on Wednesdays, commencing October 17, on the biological foundations of society; Mr. R. Aitken, five lectures on the geography of Spain and typical Spanish institutions, on Thursdays, commencing November 1; Prof. H. Wildon Carr, four lectures on the Hegelian philosophy and the economics of Karl Marx, on Tuesdays, commencing October 9; and Miss Hilda D. Oakeley, three lectures on the roots of early Greek philosophy, on Tuesdays, commencing November 27. In addition, Prof. R. J. S. McDowall, of Edinburgh, is giving an inaugural lecture in the Department of Physiology on the position of physiology in science and medicine on October 4, and Prof. W. T. Gordon is giving the Swiney lectures (12) on geology on Mondays, Wednesdays, and Fridays, commencing November 19, taking as his subject "Gem Minerals and their Uses in Art and Industry." The lecture hour in every case is 5.30 p.m.

At University College, the list of public lectures includes the following: introductory lecture by Sir Flinders Petrie on religious life in Egypt, on October 4 at 2.30 p.m.; three lectures on the new Babylonian creation and flood stories, by Dr. T. G. Pinches, beginning on October 4; an introductory lecture by Prof. C. Spearman on psychology as transfigured behaviourism; and a course of lectures by Prof. J. A. Fleming on ionic and thermionic valves, beginning on October 24. Single lectures are to be given by Miss Margaret Murray, on primitive religion, on October 5; by Prof. G. Dawes Hicks, on the philosophy of Bernard Bosanquet, on October 8; by Mr. Morris Ginsberg, on the sociological work of the late Dr. W. H. R. Rivers, by Mr. A. H. Barker, on the heating equipment of a small house, and by Miss I. C. Ward, on the application of phonetics to the curing of speech defects, at various times on October 10; and an inaugural lecture by Prof. A. V. Hill, on the present tendencies and future compass of physiological science, on October 16. Particulars of the lectures and courses should be obtained from the Secretary of University College.

A course of six lectures on the bearing of psycho-analysis upon sociological problems has been arranged by the Sociological Society, Leplay House, 65 Belgrave Road, Victoria, S.W.1. The lectures are to be given on Tuesdays, and commence on October 9 with an introductory lecture by Dr. Ernest Jones. Succeeding lectures will deal with man as an individual, the family, politics, education, and vocation. Half-price tickets are available for a limited number of students.

A series of "Celebrations," arranged by Dr. F. H. Hayward, Inspector of Schools, of 87 Benthall Road, London, N.16, will be held during the winter on certain Saturday evenings (6 o'clock) at the Birkbeck Theatre, Birkbeck College, Fetter Lane, E.C. Four of these in particular may be of interest to readers of Nature, namely: Two homage celebrations, "The Geologist," December 1, and "The Scientist" (in general), March 1, 1924, and two memorial celebrations, "Leonardo da Vinci," January 12, 1924, and "Goethe," February 9, 1924. All these four have a predominant scientific interest. Though we understand that Dr. Hayward has found it difficult to discover music and poetry that can be effectively employed in the glorification of science and its devotees, he has discovered some, and he thinks that the main purpose of the celebrations will be achieved, namely, the creation of emotional associations in connexion with the history and the methods of science. Recent studies in psychology and sociology have pointed to the conclusion that knowledge and reason are more closely related to instinct and emotion than was formerly believed. Without an emotional basis, they cannot flourish or even receive adequate recognition among the mass of mankind. Hence the importance of Dr. Hayward's attempt to employ "mass" methods and other devices.

Suggestions and criticisms are invited. Mozart's "Magic Flute" will supply some items of music, especially on March 1. Admission will be free, without ticket.

SECONDARY education in the United States in 1921 and 1922 is reviewed in Bulletin, 1923, No. 12, of the Bureau of Education, Washington. The outstanding achievement within the past few years has been an extension downwards of the secondary school system in many parts of the United States, especially in cities. Typically, the extension has taken the form of substituting for the normal sequence of 4 years of high school work following 8 years (ages 6 to 14) of elementary schooling, a system sometimes described as the 6-3-3, meaning 6 years (ages 6 to 12) of elementary schooling followed by 6 years of secondary school work divided into two administrative units of 3 years each, namely, the junior high school and the senior high school units. Essentially the change implies that the passage from the elementary to the secondary type of curriculum should synchronise with the commencement of the physical changes of adolescence. It is generally agreed in America that at this stage the pupil needs in his studies change, variety, and human interest rather than completeness and logical arrangement, and that consequently in place of the traditional seventh and eighth grade courses there should be a general survey of the chief departments of knowledge: "English literature, general social science, general mathematics, general science, foreign languages for those who desire them, music, art, physical education, and the practical arts." This holds good both for those who are to leave school at 15 and for those who are to pass on to the senior high school.

A STATISTICAL survey of education in the United States is given in Bulletin No. 16 of 1923 of the Federal Bureau. It shows the following total enrolments in 1919-20 (in thousands): kindergarten 511, elementary 20,383, secondary 2430, university, college, and professional school 462, teachers' college and normal school 163; grand total 23,950, being 22·7 per cent. of the total population. Included in the above are the following enrolments in private, that is non-state, institutions: kindergarten 30, elementary 1486, secondary 229, university etc. 281, teacher-training 14. The estimated cost of all this education, except private elementary and private secondary, is 1301 million dollars, or, in dollars per head: elementary 39, secondary 127, university, college, and professional 460, teachers' college 131, other normal schools 189. The figures are exclusive of city evening, private commercial, nurse-training, and Indian and Alaskan schools. Enrolments in these amounted to 587, 336, 55, and 32 thousands respectively. Gifts and bequests to education in 1920 reached the unprecedented total of 67 million dollars, the highest previous record being 37 million in 1916. The extent to which women teachers have taken the place of men during the past 40 years in elementary and secondary schools is strikingly shown in a table in another Bulletin, No. 29 of 1922, giving the percentage of men teachers in 1880 and at the end of each subsequent quinquennium up to 1920: 43, 37, 35, 33, 30, 24, 21, 20, 14. The average annual salaries in dollars of all teachers, men and women, in the same years are given as 195, 224, 252, 286, 325, 386, 485, 543, 871, but the last figure includes supervisors and non-teaching principals. During the past 50 years the ratio of pupils in secondary schools, compared with the total enrolment in elementary and secondary schools combined, increased from 1·2 to 10·2 per cent.

Societies and Academies.

LONDON.

Institute of Metals (Manchester Meeting), September 10.—Sir Henry **Fowler**: The use of non-ferrous metals in engineering (Autumn Lecture). Of the non-ferrous metals used by engineers, the one which has been in longest use is copper, and it is at present the one most closely associated with engineering work. The uses to which its comparatively simple alloys with tin and zinc can be put are endless. The next in importance is tin, which, alloyed with copper, lead, and antimony, gives us those white metals which are used to make bearings in machines. Aluminium is still most generally used in connexion with aeronautics.

September 11.—E. A. **Bolton**: The cause of red stains on sheet brass. The stains occur through reactions of copper oxides in the scale formed during annealing and in the pickling medium. Cupric oxide, contrary to the usual opinion, is as harmful as cuprous oxide. The presence of these oxides may be due to careless washing after pickling, resulting in the presence of acid and salts during annealing, the presence of iron in the brass or upon its surface, the use of impure rolling oils, etc. The main cause of the oxidation of the copper is the use of old-fashioned annealing furnaces in which the flames impinge directly upon the brass. Possible remedies for the red-stain trouble are suggested.—H. W. **Brownsdon**: Brinel hardness numbers. Brinel numbers for non-ferrous metals should be expressed in figures that are comparable. This could be done if balls and loads are used for which the ratio L/D^2 (the load in kilograms divided by the square of the ball diameter in millimetres) is constant. Some one ratio for L/D^2 should always be used for one class of alloys; for the copper alloys with Brinell hardness numbers from about 40 to 200, the choice should rest between the ratio 5 as standardised in the United States or the ratio 10 which is favoured in some quarters in Great Britain.—A. H. **Mundey** and John **Cartland**: Stereotyping. Stereotyping is generally regarded by printers as almost a trade secret. The process was invented by a practical metallurgist, William Ged, an Edinburgh goldsmith, in 1750. Stereotyping was traced from the plaster-of-Paris process to the use of papier-maché flong, and from the simple stereo plates for flat-bed machines to the elaborate requirements of the modern newspaper. A high degree of accuracy is demanded in the mechanical and metallurgical details in order to produce the good results which are a commonplace to everyone.—J. D. **Hannah** and E. L. **Rhead**: Crystallisation effect on galvanised iron sheets. Manufacturers of galvanised iron and steel goods always seek to produce a zinc-covered surface having large characteristic spangles. Small spangles or lack of spangles is disliked. The metal—iron or steel—has practically no influence on the result if the temperatures are satisfactorily maintained. Pure zinc does not yield large spangles, and too high a temperature interferes by producing large quantities of a zinc-iron compound which crystallises in needles on the metal. The presence of tin or aluminium does not produce the desired result, but lead is effective. The separation of the impure zinc into conjugate solutions, lead-rich and zinc-rich, at the dipping temperature, and the method of subsequent crystallisation, may be the causes of these effects.—R. C. **Reader**: Effects of rate of cooling on the density and composition of metals and alloys. The densities of pure metals, and of alloys which solidify at a constant temperature, are not affected by the rate at which they solidify.

With alloys which solidify over a range of temperature, the slower the rate of solidification the lower is the density, and when they are prepared in cylindrical chill moulds, they are less dense in the centre than at the outside. When prepared in chill they are richer on the outside in the component of the lower melting point.—A. H. **Mundey** and C. C. **Bissett**: The effect of small quantities of nickel upon high-grade bearing metal. Nickel is now added to the well-known bearing metal consisting of tin 93 per cent., antimony 3·5 per cent., copper 3·5 per cent. Tensile, compression, and hardness tests gave no indication of improvement. The comparison of hardness at varying increased temperatures exhibited no improvement. In the case of the alloy with no nickel, the hard copper-tin constituent is very marked in its characteristic crystalline formation as seen under the microscope. The presence of nickel even in small quantities results in a great diminution of this crystalline structure.—Hikozo **Endo**: The measurement of the change of volume in metals during solidification. In the casting process it is very important to know to what extent a change of volume occurs during solidification. In 1888, Vincentini and Omodei calculated the change of volume of some fusible metals during solidification from the change of density at the melting point. E. Wiedemann, Paul Pascal, and Louis Hackspill also used this method. M. Toepler studied the change of volume by means of a dilatometer; he suggested a relation of the change of volume of a metal at melting point to its atomic weight. K. Bornemann and F. Sauerwald measured the density of metals at various high temperatures, using the principle of Archimedes, by means of a mixture of sodium and potassium chlorides as liquid. The method of investigation now used for metals having melting points up to 1100° C., which was suggested by Prof. K. Honda, consists in the measurement of the change of buoyancy of a metal suspended in an inactive liquid during its solidification or melting by means of a thermobalance.

September 12.—Marie L. V. **Gayler**: The constitution and age-hardening of the quaternary alloys of aluminium, copper, magnesium, and magnesium silicide. Alloys containing up to 6 per cent. copper, 4 per cent. magnesium, and 4 per cent. magnesium silicide were used. When copper, magnesium, and magnesium silicide are present in aluminium, any two of these components have a marked effect on the solubility of the third and ultimately $CuAl_2$ and Mg_2Si are both thrown out of solution. If copper and magnesium are present in a ratio greater than 12 to 5 approximately, then the alloys when quenched from high temperatures age-harden at room temperature, owing to the difference in the solubility of Mg_2Si at the quenching and ageing temperature. Age-hardening of alloys of the "Duralumin" type is due primarily to Mg_2Si, and the addition of magnesium and copper is important since both reduce the solubility of Mg_2Si at high and low temperatures and consequently reduce the maximum age-hardness due to Mg_2Si.—Ulick R. **Evans**: The electro-chemical character of corrosion. There are two main types of corrosion: (1) that accompanied by evolution of hydrogen is characteristic of reactive metals placed in acid solutions, but the velocity varies greatly with the degree of purity of the metal; (2) slower corrosion, determined by the diffusion of oxygen to the metal, and comparatively independent of the purity. When a metal is immersed in a solution of potassium chloride, alkali is produced at the cathodic portions, the chloride of the metal at the anodic portions, and the hydroxide is precipitated where these meet. The electric current produced accounts for the greater part of the corrosion actually observed. Generally the cathodic areas are those to which air has free access, while the anodic areas are those protected from aeration. Corrosion usually proceeds most rapidly at the comparatively unaerated places—hence the intense corrosion observed in "pits" and over areas covered up by porous corrosion-products.—Douglas H. **Ingall**: Experiments with some copper wire; cohesion a function of both temperature and cold work. Five samples of copper wire were used: soft annealed and four degrees of cold work given by 25, 40, 50, and 75 per cent. reduction of area by drawing. The cohesion at high temperatures was determined by placing given loads on the wire at atmospheric temperature, heating the wire and determining the temperature at which it broke. All the samples gave similar graphs in which with rise of temperature the cohesion decreased along a straight line to a constant critical temperature of 350° C., beyond which the cohesion was represented by a sharply descending curve. The equations to the straight lines $C = a - bT$ and to the curves $TC^n = k$ (where C = cohesion and T = temperature) showed that the percentage increase of the constant b and the percentage decrease of the constant n were represented by the corresponding percentage reductions for any given cold worked wire, with the exception of 75 per cent. reduced wire. At the critical inflection temperature the material was comparatively extremely fragile.—D. **Hanson**, C. B. **Marryat**, and Grace W. **Ford**: Investigation of the effects of impurities on copper. Pt. I.—The effect of oxygen on copper. The effect of oxygen, up to a concentration of 0·36 per cent., on *pure* copper, was investigated. The mechanical properties are not much affected by small quantities of oxygen, and copper containing as much as 0·1 per cent. differs very slightly from pure copper. The electrical conductivity does not fall rapidly, and values exceeding 100 per cent. of the International Standard are obtained in all annealed materials containing less than 0·1 per cent. of oxygen. This is due to the low solubility of the oxide in solid copper. The oxygen-bearing metals can be considered as a heterogeneous mixture of pure copper and finely divided particles of cuprous oxide. There is a soft ductile copper matrix, in which harder particles of cuprous oxide are distributed so as to form a mechanical mixture.—Hugh **O'Neill**: Hardness tests on crystals of aluminium. Brinell tests showed that at low loads the different crystallographic planes resist penetration to different degrees, and give indentations of different shapes. In the Brinell sense the (110) face is the "hardest" and the cube (001) face appears to be the "softest." But the load required to immerse the ball is apparently the same in all cases. Crystal boundaries are without any appreciable effect in increasing the resistance of aluminium to penetration.—H. I. **Coe**: The behaviour of metals under compressive stresses. Compression tests carried out on small cylinders of metals show that with successive increments of loads plastic flow occurs, after the elastic limit has been exceeded, at an increasing rate. At a certain load the rate of flow changes abruptly, metals such as tin and lead becoming perfectly plastic, harder metals becoming more plastic than under preceding loads and immediately succeeding loads. The term "critical plasticity" is used to indicate the change in the rate of plastic deformation which most metals exhibit at a particular load. Annealed metals flow at a comparatively low load and the rate of flow increases up to the load corresponding to critical plasticity; when worked, they are more resistant to compressive stresses until they approach the load corresponding to a critical plasticity, when they suddenly collapse and a marked temporary flow occurs.—Albert M.

Portevin and **Pierre Chevenard**: A dilatometric study of the transformations and thermal treatment of light alloys of aluminium. Dilatometric methods, using the recording differential dilatometer, permit of the study of the transformations and the mechanism of heat-treatment of the light alloys of aluminium-magnesium-silicon, and in general, of alloys containing two-phase, univariant transformations. The study of the constant temperature transformations by the differential dilatometer, using a high sensitivity apparatus, leads to general expressions representing the phenomena as functions of time and temperature. Quenching and tempering in these alloys can be interpreted by the known variations in the solubility of Mg_2Si in the solid state, without assuming any further transformations.—P. **Soldau**: Equilibrium in the system gold-zinc (based on investigations of electrical conductivity at high temperatures). The alloys of gold and zinc belong to the type of AR-brasses, where A is a metal belonging to the first and R to the second group of the periodic system. These alloys are of considerable practical importance, as in their chemical nature they are very close to the ordinary brasses. For the determination of electrical conductivity at high temperatures, a special apparatus was constructed which was checked by determining the transformation temperatures in iron and steel and comparing the results with those obtained by other methods.

PARIS.

Academy of Sciences, September 3.—M. A. d'Arsonval in the chair.—Alfred **Errera**: A theorem of linkages.—Alexandre **Rajchman**: The Riemannian theory of trigonometrical series.—M. **Puthomme**: Contribution to the study of the secondary X-rays. Two metallic wires, in the form of a cross, give a single sharp radiographic image, but if a metallic screen such as a sheet of lead, be placed between the X-ray bulb and the wires, then three images are observed, one on each side of the initial image. The two additional images are due to secondary rays starting from the edges of the lead screen. The fact that a needle imbedded in the body may sometimes give a faint extended image rendering it difficult to locate is probably due to the same phenomenon.—E. F. **Terroine**, P. **Fleuret**, and Th. **Stricker**: The rôle of the deficient proteids in supplying the minimum nitrogen requirement. Experiments on the nitrogen assimilated by growing pigs from ammonium citrate and from gelatin. The amount assimilated varies greatly with the individual animal. Gelatin proved to be superior to ammonium citrate as a source of nitrogen.—Mme. **Randoin**: Study of the vitamins in molluscs. The presence of the antiscorbutic factor in the oyster. From experiments on guinea pigs it is concluded that the addition of oysters in suitable quantity to a diet not containing vitamin-C is sufficient to prevent symptoms of scurvy.—M. **Athanassopoulos**: The tunny fish of Greece.

Official Publications Received.

Arkiv för Matematik, Astronomi och Fysik utgivet av K. Svenska Vetenskapsakademien, Band 17, No. 19. Meddelande från Lunds Astronomiska Observatorium, No. 102: Contributions to the Analytical Theory of Sampling. By S. D. Wicksell. Pp. 46. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: Wheldon and Wesley, Ltd.; Berlin: R. Friedlander und Sohn; Paris: C. Klincksieck.)

Meddelanden från Lunds Astronomiska Observatorium. Serie II, Nr. 29: Flächenhelligkeiten von 566 Nebelflecken und Sternhaufen, nach photometrischen Beobachtungen am 49 cm. Refraktor der Universitäts-Sternwarte, Strassburg (Elsass), 1911–1916. Von Carl Wirtz. Pp. 63. Serie II, Nr. 30: Star-gauges by William Herschel and John Herschel. Edited by C. V. L. Charlier. Pp. 29. (Lund: Scientia Publisher.)

Kungl. Fysiografiska Sällskapets Handlingar, Band 34, Nr. 2. Meddelanden från Lunds Astronomiska Observatorium. Serie II, Nr. 31: Star-gauges at the Observatory of Lund. By C. V. L. Charlier, F. A. Engström, P. B. Fänge, K. A. W. Gyllenberg, C. I. Lundahl, K. G. Malmquist, J. B. Ohlsson, S. D. Wicksell. Edited by C. V. L. Charlier. Pp. x+207. (Lund: C. W. K. Gleerup; Leipzig: Otto Harrassowitz.)

The North of Scotland College of Agriculture: County Extension Department. Bulletin No. 28: Reports on Field Experiments with Oats, Turnips and Potatoes carried out on Farms in the College Area during the Years 1919, 1920, 1921. Pp. 76. (Aberdeen.)

The North of Scotland College of Agriculture. Bulletin No. 29: An Experiment on the Control of Finger-and-Toe by Liming. By Prof. James Hendrick. Pp. 15. (Aberdeen.)

Queensland Department of Mines: Geological Survey of Queensland. Publication No. 272: Geology of the Walloon-Rosewood Coalfield. By J. H. Reid. Pp. 69+2 maps. (Brisbane: A. J. Cumming.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 20: Recent Advances in Instruction in Music. By Will Earhart and Charles N. Boyd. Pp. 21. Bulletin, 1923, No. 21: Specimen Junior High School Programs of Study. Compiled by W. S. Deffenbaugh. Pp. 28. Bulletin, 1923, No. 28: Vocational Education. By William T. Bawdon. Pp. 26. Bulletin, 1923, No. 34: Higher Education 1920–1922. By George F. Zook. Pp. 83. (Washington: Government Printing Office.) 5 cents each.

Department of the Interior: United States Geological Survey. Bulletin 717: Sodium Sulphate; its Sources and Uses. By Roger C. Wells. Pp. iv+43. 5 cents. Bulletin 718: Geology and Ore Deposits of the Creede District, Colorado. By William H. Emmons and Esper S. Larson. Pp. ix+198+12 plates. 40 cents. Bulletin 738: The Commercial Granites of New England. By T. Nelson Dale. Pp. xv+488+34 plates. 50 cents. Bulletin 745: The Kotsina-Kuskulana District, Alaska. By Fred H. Moffit and J. B. Mertie, Jr. Pp. ix+149+19 plates. 40 cents. Bulletin 750-A: Ilsemannite at Ouray, Utah. By Frank L. Hess. Pp. 16+2 plates. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 469: Surface Waters of Wyoming and their Utilization. By Robert Follansbee. Pp. x+331. 40 cents. Water-Supply Paper 495: Geology and Ground-Water Resources of Sacramento Valley, California. By Kirk Bryan. Pp. xi+285+19 plates. 60 cents. Water-Supply Paper 496: The Industrial Utility of Public Water Supplies in the United States. By W. D. Collins. Pp. iv+59. 10 cents. (Washington: Government Printing Office.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 32: The Cotton Plant in relation to Temperature and Rainfall. By C. B. Williams. Pp. vi+2 charts. (Cairo: Government Publications Office.) P.T. 2.

Report of the Government Chemist upon the Work of the Government Laboratory for the Year ending 31st March 1923. With Appendices. Pp. 34. (London: H.M. Stationery Office.) 1s. 6d. net.

Bulletin of the National Research Council. Vol. 6, Part 2, No. 33: On the Formulation of Methods of Experimentation in Animal Production. By E. B. Forbes and H. S. Grindley. Pp. 54. 1 dollar. Vol. 6, Part 3, No. 34: Causes of Geographical Variations in the Influenza Epidemic of 1918 in the Cities of the United States. By Ellsworth Huntington. Pp. 36. 75 cents. Vol. 6, Part 4, No. 35: Apparatus used in Highway Research Projects in the United States. By C. A. Hogentogler. Pp. 91. 1.50 dollars. (Washington: National Academy of Sciences.)

Year Book of the Michigan College of Mines, 1922–1923, Houghton, Mich. Announcement of Courses, 1923–1924. Pp. 125. (Houghton, Mich.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Kitts-Nevis, 1921–1922. Pp. iv+44. (Barbados.) 6d.

The East London College (University of London). Calendar, Session 1923–1924. Pp. 164. (London: Mile End Road.)

Diary of Societies.

MONDAY, OCTOBER 1.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—A. Ferguson, Improved Method for Mass Production of Tank Glass Bottles, Jars, etc.

WEDNESDAY, OCTOBER 3.

SOCIETY OF PUBLIC ANALYSTS (at Chemical Society), at 8.—J. H. Coste, E. R. Andrews, and W. E. F. Powney: The Sampling of Coal; the General Problem and some Experiments.—H. G. Stocks: A New Test for distinguishing Castor Oil.—A. E. Etheridge: The Volumetric Estimation of Vanadium in Steel.—C. L. Hinton and T. Macara: The Iodimetric Determination of Sugars.

THURSDAY, OCTOBER 4.

CHILD-STUDY SOCIETY (at the Royal Sanitary Institute), at 6.—Discussion opened by Miss Norah March: The Report of the Commission in relation to the Teaching of Biology in Schools.

CHEMICAL SOCIETY, at 8.—E. B. R. Prideaux and A. T. Ward: A Revision of the Dissociation Constants of Weak Inorganic Acids. Part I. Boric Acid. Part II. Phosphoric Acid.—C. N. Hinshelwood and C. R. Prichard: Two Heterogeneous Gas Reactions.—C. N. Hinshelwood and C. R. Prichard: A Homogeneous Gas Reaction. The Thermal Decomposition of Chlorine Monoxide. Part I.—R. G. W. Norrish and E. K. Rideal: The Direct Union of Oxygen and Sulphur.—W. R. Ormandy and E. C. Craven: Note on Aqueous Formaldehyde Solution.—H. Hawley and H. J. S. Sand: The Interaction of Potassium Tetroxide with Ice and with Dilute Sulphuric Acid.

PUBLIC LECTURES.

THURSDAY, OCTOBER 4.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: Religious Life in Egypt (Introductory Lecture).

LONDON SCHOOL OF ECONOMICS, at 5.—Sir Arthur Newsholme: Measurement of Progress in Public Health (William Farr Lecture).

UNIVERSITY COLLEGE, at 5.15.—Dr. T. G. Pinches: The New Babylonian Creation and Flood Stories. (Succeeding Lectures on October 11 and 18.

KING'S COLLEGE, at 5.30.—Prof. R. J. S. McDowall: The Position of Physiology in Science and Medicine.

FRIDAY, OCTOBER 5.

UNIVERSITY COLLEGE, at 5.—Miss Margaret A. Murray: Primitive Religion.

NATURE

SATURDAY, OCTOBER 6, 1923.

CONTENTS.

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The Imperial Conference and Natural Resources.

AMONG the problems being discussed at the Imperial Conference, now being held in London, one of the most important is the development of the natural resources of the British Empire, and this is a question which can no longer be approached on old-fashioned empirical lines. On the contrary, a successful solution can be expected only if the whole matter is put on a rigidly scientific basis.

The first need is for a scientific survey of each area of the Empire as a possible home of man. The result of such a survey would be a store of definite knowledge as to (1) the various raw materials (food and other) to be expected from each area, and (2) the extent to which any area at present contributes its proper share of such raw materials.

Two facts must, however, be faced before entering on any such survey for any part of the Empire. One is that the Empire is, politically and economically, oceanic. We depend on the ocean not only for strategic security, but also for economic and commercial prosperity; and our consciousness of this has tended or tempted towards excessive dependence, in the form of neglect of the tiny, but vital, home supplies, until we no longer attempt to grow bread enough for our needs during even a quarter of the year. Indeed, Mr. Churchill's famous motor park is still a wilderness of hulks cumbering some of the best wheat land in England; and across the Middlesex border from Slough a housing authority thought that the best "brick earth" in Middlesex was a good foundation for brick cottages. We may agree entirely that "working men had as much right as any one else to the best land in the parish," and yet question the suitability of "brick earth" for any house-sites and resent its being alienated from its proper work of providing food by intensive culture.

Space forbids detailed treatment of the homeland, but the fundamental factors must be kept in mind. In the first place, we ought to add 8,000,000 acres to our arable area, and put 250,000 men on them; then, in any emergency, we could guarantee four-fifths of the adequate minimum of wholesome and nourishing food for all our people. Then literally some millions of our people never taste a drop of fresh English milk; and the way to increase and cheapen the supply is to increase our arable area. Denmark is so small and so highly specialised that it scarcely gives a fair comparison. But in 1913 even Germany produced 485 lb. of "bread" per head of population (against our 90 lb.), and so had only 25 per cent. of her farm area under grass (against our 60 per cent.), and was able to rear one head of cattle to the acre, while we reared only one to three acres.

Lastly, our method of raising meat is appallingly

wasteful. It takes 48 lb. of cereals fit for human use to raise one pound of beef; even the pig, by far the most economical converter, consumes 3,000,000 tons of "human" food to produce 250,000 tons of pork, ham, and bacon. The saving of time and money and ships, if we imported the meat instead of the food for cattle, would almost pay our whole unemployment dole; and even the bacon, equal in quality to that for which we paid Denmark about 30,000,000*l.* last year, could be imported from our own tropical dominions, for tropical bacon is as "firm" as English bacon, if the pigs are given coconut in their food.

The British Empire, unlike other big empires, is an epitome of the world, so that we have naturally a climatic base for classifying natural regions; and we can distinguish half-a-dozen broad types. Each of them has its appropriate products, and should be encouraged to produce these; and the various areas, being scattered over the whole world, have complementary seasons. Of these broad types the most important are the temperate, the Trade-wind, and the monsoon.

The temperate type, as seen in Canada, has marine margins and continental interior; and these marine margins, whether dominated by snow, as in the east, or by rain, as in the west, are specially timber areas and should grow and market forest products. In 1922, Canada produced very nearly 3,000,000 cords of pulpwood and more than 1,000,000 tons of newsprint; and yet just before the War we were importing from Germany more than twice as much wood-pulp as we imported from Canada, and more than ten times as much paper.

The cleared forest is not suited either by soil or by climate to the growing of grain, but makes admirable pasture; and exports should be in small, solid, and imperishable form, *e.g.* butter and cheese. Canada and New Zealand already send us 80 per cent. of all our imported cheese, and Canada alone could supply all our needs. Off each margin, a cold sea current is exceedingly favourable to fishing, and on each margin orchard trees flourish almost as well as forest trees. Fish, fruit, forest, and dairy products are, therefore, natural exports. The dry continental interior is natural grassland with early summer rain, which is just as favourable to grain-growing as the perennial rain of the margin is to forest. Canada is now the largest producer of wheat in the world—capable of producing 400,000,000 bushels a year.

Our Trade-wind areas are partly insular and partly continental. The islands already produce the finest sugar and coffee in the world, and have almost unlimited possibilities in the way of raising fruit and tobacco. They could easily produce all the sugar and all the coffee that we need, and yet, in 1913, 90 per cent. of our sugar and 85 per cent. of our coffee came from outside the Empire.

The continental part of the Trade-wind region is mainly savana, capable of producing almost unlimited supplies of cattle and maize and tobacco, and in several areas already raising large quantities of cotton, to which the *slow* changes of Trade-wind climate are very favourable, as they are also to tobacco. For example, Nyasaland raises excellent "Egyptian" cotton on its heavy soil, and equally good tobacco on its light soil. If every native on this African savana was guaranteed a supply of "Salisbury White" maize, and was excused his hut tax if he planted a certain area under cotton, the British Empire would become the greatest producer of maize in the world, and in two years the African savana would be sending us 2,000,000 bales of cotton.

This question of cotton, however, is more important in the monsoon region. India already rules the market of the world for jute, tea, oil-seeds, and rice; and her population is of a very different type from that in Africa. India is, therefore, the only area where there can be an *immediate* increase of any product which requires a great deal of labour; but, unfortunately, India, like Nigeria, being a monsoon area, gets its heat before its rain—which greatly handicaps the quality of many crops, especially cotton. In the meantime, India raises the worst cotton in the world, so far as length of staple is concerned, and very nearly the worst in the world for yield per acre (85 lb.). But wherever cotton can be grown entirely by irrigation, as in the north-west, or where the rain comes before the heat, as in the extreme south-east, there could be a very great increase of "calico" cotton—our greatest need; and India is not troubled, as Nigeria is, with a short growing-season, which involves the natives in the necessity of providing all food crops before thinking of growing cotton.

These scattered examples may illustrate the sort of lines on which a geographical survey of the Empire would proceed. Such a survey has been already roughly made, and its results may be summarised as follows:—The Empire can produce: (1) all the wheat and oats, maize and rice, that we need, and most of the barley; (2) all the tea, coffee, cocoa, sugar, and oil-seeds (margarine); (3) all the beef, mutton, pig, and rabbit products that we need, and most of the leather; (4) all the wool, rubber, jute, and sisal, and fully half the cotton; and (5) all the most important constructional and industrial timber. In some of these cases, the Empire is already absolutely supreme; *e.g.* tea, cocoa, wool, rubber, and palm oil. All of them could be produced without a raising of price, probably with an actual lowering of it; and it is obvious that an adequate minimum of all should be produced. Only in this way can we get rid of a foreign monopoly, as in cotton, and foreign control, as in maize and meat.

L. W. LYDE.

Aitken's Scientific Papers.

Collected Scientific Papers of John Aitken, LL.D., F.R.S. Edited for the Royal Society of Edinburgh (with Introductory Memoir) by Dr. C. G. Knott. Pp. xxi+591. (Cambridge: At the University Press, 1923.) 30*s*. net.

THE late Dr. John Aitken bequeathed to the Royal Society of Edinburgh a sum of 1000*l*. to be expended in issuing a reprint of his more important scientific papers. The work of editing the collection was assigned by the Society to its General Secretary, the late Dr. C. G. Knott, and the present volume is the result.

Aitken's contributions to science and to its literature extend over half a century, and include about a hundred papers contributed to various societies and periodicals. The subjects ranged over a remarkably wide field. Safety-valves on steam boilers, colour vision, glaciers, thermometer screens, colours in the sky and sea, are only a few of the subjects dealt with beyond the main work which occupied his attention for more than forty years. The selection here presented consists of thirty-eight of the more important papers, and has been made with great care. The volume, which includes a brief account of Aitken's life and work, meets a real need, for in recent years the Royal Society of Edinburgh has had to reprint some of Aitken's papers more than once.

The most notable contribution made to science by Aitken was his study of dust in the atmosphere and of the physical phenomena to which it gives rise. This forms the subject of no fewer than fourteen of the collected papers. He was drawn to the inquiry from consideration of the phenomena accompanying changes of state and especially of the acceleration of such changes in the presence of "free surfaces." In his first paper, on "Dust, Fog, and Clouds," he states his main conclusion.

"Molecules of vapour do not combine with each other and form a particle of fog or mist; but a free surface must be present for them to condense upon. The vapour accordingly condenses on the dust suspended in the air, because the dust particles form free surfaces at which the condensation can take place at a higher temperature than when they are not present. Where there is abundance of dust there is abundance of free surfaces, and the visible condensed vapour forms a dense cloud: but when there are no dust particles present there are no free surfaces, and no vapour is condensed into its visible form, but remains in a supersaturated vaporous condition till the circulation brings it into contact with the free surfaces of the sides of the receiver, where it is condensed."

Aitken was not the first to reach this conclusion, for he had been anticipated by Coulier, whose results had been published five years earlier. But of the absolute independence of Aitken's work there can be no doubt, and his more extensive researches opened out the field of inquiry in such a manner that his name will always be associated with the subject. He proceeded in later papers to develop it further, to describe ingenious apparatus devised for counting the number of dust particles (or rather, condensation nuclei) in unit volume of air, and to state the results of a large number of observations, in widely different conditions, on the "dustiness" of air in houses, towns, open country, and seashore, and on mountain heights.

The present writer heard Aitken giving some of these papers to the Royal Society of Edinburgh, and had the privilege of working at the subject under his guidance. One was at first struck with the confidence with which Aitken stated his results, but there was always the note of reservation when a possible alternative was presented. Looking back on these early days, and in the light of later work, it can be seen that although his results seemed straightforward and their interpretation obvious, Aitken was troubled by the fear that something more lay behind them. This is evident from his guarded language in speaking of the arrangements for filtering dust out of a sample of air and his insistence on the readiness with which condensation takes place in the presence of alkaline salts and sulphur compounds. The fuller knowledge came later with Wilson's experiments on the condensation of supersaturated vapour upon the ions in a gas; and evidence, collected together in Dr. Simpson's recent Royal Institution lecture (NATURE Supplement, April 14), has accumulated to show that condensation at or near normal pressure takes place only on the hygroscopic dust particles. In another direction, too, Aitken's work has been supplemented. His explanation of the production of fog, especially the smoky fog of towns, was insufficient inasmuch as it (necessarily at that time) took no account of those temperature inversions at comparatively low altitudes which prevent the lateral or vertical escape of smoke-laden foggy air. But he was more nearly correct in his deduction that—

"We must remind those who are crying for more perfect combustion in our furnaces and grates that combustion, however perfect, will not remove or diminish fogs. It will, however, make them cleaner, take away their pea-soupy character, but will not make them less frequent, less sulphurous, less persistent, or less dense."

Aitken's next contribution of importance was his paper "On Dew" (1885), in which he showed that deposits of dew are produced by the condensation of water vapour rising from the soil, and that the dewdrops on grass are formed from water exuded from the pores

of the leaves when the overlying air is already saturated. His excursion into the dynamics of travelling cyclones and anticyclones forms a less fruitful but not less interesting portion of his work. By an experimental arrangement of the ingenious kind that might be expected from him, he sought to demonstrate the flow of air into a region of low pressure. Inside, and near the lower end of, a vertical metal tube, three gas jets were lit and the lines of flow of air into the updraught in the tube were then studied. The spiral motion was represented as being due to non-uniform distribution of velocity in the horizontal plane through the lower end of the tube. His theory was that anticyclonic areas supplied descending and therefore heated air to cyclonic areas, and also supplied "the cyclone with part of the tangential force necessary for producing the spiral circulation so well known in cyclones." Further, that—

"the upper winds, circling from the anticyclones, and to the cyclones, by moving more quickly, and by moving at an angle across the lower air, tend to prevent the latter rising, even although it be the lighter. The effect of this . . . is to drive the hot moist air lying near the earth's surface to the circumference of the anticyclone where it is picked up by the cyclone, and as the spirally moving cyclonic winds also tend to prevent the lower air rising, the hot moist air is swept into the front of the low-pressure area . . . and it is drawn into the centre of the depression and . . . forms the core of the cyclone."

Sir Napier Shaw has pointed out, however, that the difficulty lies in deciding whether or how far any experiment such as Aitken's really reproduces the natural conditions on the larger scale. To begin with, that portion of the atmosphere within a cyclonic area has no resemblance to a vertical column the height of which is a dozen times its diameter; its axis is most probably not vertical; it is not provided with a constant heat supply at its base; its core is almost certainly not a mass of warm moist air; and the distribution of temperature is not symmetrical about its "centre." Lastly, the whole system moves in a field of force the characteristics of which are not altogether simple. Thus, although Aitken's experiment forms an ingenious illustration of eddy motion in a fluid, his theory of cyclonic motion has not done much to advance the subject, except that it has stirred up the interest of others in the matter. Recent years have brought additional information, but the end is not yet; nor will that be reached without more extensive exploration and study of the first six or eight kilometres of the atmosphere lying over and within cyclonic areas. This, perhaps, is the greatest need of the meteorology of to-day.

Notice must be taken of the admirable sketch of Aitken's work, drawn up by the late Dr. C. G. Knott. He shows Aitken as a typical example of the private scientific inquirer—a class to whom British science owes much. With ample private means, he pursued his inquiries in his own time and in his own way, happy in freedom from those distractions which seem inseparable from the occupation of official position. He did his work because he loved it; he sought for the truth because it was "something true and good for ever, not the mere outcome of craft or expediency."

Dr. Knott's editorial work has been done with care and discrimination. But a melancholy interest attaches to it, for the date of his *imprimatur* shows it to have been the last piece of work in a long and useful life.

A. C. M.

A Zoological Tribute.

Bydragen tot de Dierkunde. Uitgegeven door Het Koninklijk Zoologisch Genootschap Natura Artis Magistra te Amsterdam. Feestnummer uitgegeven bij gelegenheid van den 70sten geboortedag van Dr. Max Weber, oud Hoogleeraar in de Zoologie aan de gemeente Universiteit te Amsterdam. Pp. 342. (Leyden: J. Brill, 1922.) 25 guilders (*2l. 1s. 8d.*).

TOWARDS the end of last year the Royal Zoological Society Natura Artis Magistra of Amsterdam issued the twenty-second number of its publication, "Bydragen tot de Dierkunde" (Contributions to Zoology), on the occasion of the seventieth birthday of Prof. Max Weber. To this large volume no less than forty-four zoologists have contributed papers on various subjects, and all thus unite, each in his own way, "to weave a small leaflet into the wreath which his adorers, friends, and pupils offer him on this festivity."

As the table of contents itself includes a considerable number of papers, it is easy to understand that we cannot possibly give a summary of each contribution in particular, for such an account would exceed the limits of the space available in NATURE. We must therefore content ourselves with mentioning those of special interest, first to the distinguished zoologist to whom the collection is dedicated, and next from the point of view of science.

No more sincere admiration of Weber's investigations of the fauna of the Dutch East Indies, and his endeavours to establish scientific collaboration between the colonies and the motherland, can be expressed than is done by Koningsberger in his partly historical, partly modern, consideration of biological research work in Dutch Asiatic colonies. The zoogeographical problems of this archipelago, which have

occupied Weber's interest since his first explorations in those regions, now nearly forty years ago, furnish the reason for Hugo Merton's contribution, a paper "Zur Zoogeographie der Aru- und Keiinseln," resuming the results of his own scientific expedition in this interesting eastern region which shows such relationship to Australian fauna.

The connexion with the fauna of British India, studied several years ago by the scientific staff of the Indian Museum at Calcutta, induced Annandale to choose as his subject a discussion of the "Marine Element in the Fauna of the Ganges." The biology of such intermediate territories between normal fresh-water and real sea-water has always been a fairly difficult subject for comparison in different areas, and this may be partly attributed to the lack of agreement in the use of the expression "brackish water."

An attempt to suggest some unanimity has been made here by Redeke: "Zur Biologie der niederländischen Brackwassertypen." Following Einar Naumann's investigations of the food-salts of the aquatic organisms, Redeke based his division of the conditions of life in brackish water on so-called chlorine spectra. These pages should be of special interest to several British zoologists. The most important divisions are:

Fresh water, up to 100 milligrams per litre.
Oligohalin (slightly brackish), 100 to 1000 milligrams per litre.
Mesohalin (brackish), 1000 to 10,000 milligrams per litre.
Polyhalin (very brackish), more than 10,000 milligrams per litre.

Several species are mentioned that are typical for each salinity. I hope British zoologists will adopt these divisions also—or propose better ones.

As the volume is dedicated to the greatest living Dutch zoologist, we are not astonished to meet a number of papers which are more or less in close relation to Weber's own fields of investigation. Thus his friend, L. F. de Beaufort, gives "Some Remarks on the Anatomy of the Melano-tæniinæ," those remarkable fresh-water fishes of Australia and part of the neighbouring archipelago. A fine Röntgen photograph shows their peculiar skull form, with the characteristic protruding mouth caused by the shape and position of the præmaxillæ.

H. C. Delsman opens here a series of studies on the development of larval fish of the Java Sea and surrounding waters, carried out in the laboratory for marine investigations at Batavia. This branch of science may have a successful future for purely scientific as well as for economic purposes, as hitherto it has been very little studied in tropical seas.

The director of the Zoological Garden at Amsterdam, C. Kerbert, contributes from his rich collection and his long experience a survey of what we know about pregnancy, birth, adolescence, and lifetime of *Hippopotamus amphibius*, observed in the different zoological gardens of Europe.

Only a short time before his death, Kükenthal drew up the results of his study of a fœtus of the Greenland Right Whale, "Die Brustflosse des Groenlandswales, *Balæna mysticetus* L." The study of these largest of mammals is a territory on which Weber and Kükenthal often met, and more than once has been the subject of sharp controversy as well as of sincere appreciation.

We now pass to those papers which are more distantly related to Weber's personality or to his own scientific work, and as such can only be regarded as the outcome of the focus of the authors' immediate interest. They fall into two chief groups: systematic and anatomical-phylogenetical. De Meyere on Javanese agromyzines; Döderlein on the genus Calliaster; de Man on marine nematodes; Eigenmann, Metzelaar, Clark, Nelly de Rooy, and Horst; indeed, they are not the least of zoologists who work as "mere" systematists. An admirable paper on "Repeated changing of Body-forms in the Course of the Phylogeny of Teleosteans" has been contributed by Abel. Here again we are astonished at the author's "biological" treatment of a subject so dead as the palæontology and phylogeny of extinct fishes.

Dollo, in his own way of discussing matters, gives a survey of some of the remarks and opposition offered against his theory of evolution, dealing here with the secondary nectonic life of Pristis and Ceratoptera and the rolling back of the curled shells of fossil tetrabranchous cephalopods. According to Dollo, these instances are but secondary adaptations accomplished along another way.

Finally, we wish to direct attention to Dubois' paper on the question whether the brains of domesticated dogs have increased in volume in comparison with those of wild races of dogs and foxes. He has worked out accurately the results of his measurements and weighings, and concludes that, contrary to the usual opinion that domestic animals should have increased in brain weight, tame dogs at least are provided with smaller brains than their wild congeners.

From the fourteen contributions to this work written in the English language reference can be made only to that of R. F. Scharff "On the Origin of the West Indian Fauna"—a complicated problem.

The volume is attractively illustrated, the first full-page being a fine portrait of Weber. Paper, print, and illustrations are fully up to the usual standard of the publications of the firm of E. J. Brill, of Leyden.

W. G. N. van der Sleen.

American Chemical Monographs.

(1) *The Origin of Spectra.* By P. D. Foote and F. L. Mohler. (American Chemical Society Monograph Series.) Pp. 250. (New York: The Chemical Catalog Co. Inc., 1922.) 4.50 dollars net.

(2) *The Properties of Electrically Conducting Systems: Including Electrolytes and Metals.* By Prof. Charles A. Kraus. (American Chemical Society Monograph Series.) Pp. 415. (New York: The Chemical Catalog Co. Inc., 1922.) 4.50 dollars.

(3) *Glue and Gelatin.* By Jerome Alexander. (American Chemical Society Monograph Series.) Pp. 236. (New York: The Chemical Catalog Co. Inc., 1923.) 3 dollars.

(4) *Catalytic Action.* By K. George Falk. Pp. 172. (New York: The Chemical Catalog Co. Inc., 1922.) 2.50 dollars.

(1) THE monograph on "The Origin of Spectra" has been well written by highly qualified authors. The subject is not an easy one to handle, especially in view of the fact that the mathematics involved in the quantum theory of spectra is so difficult that only those who have specialised in advanced mathematics can hope to follow it. The utmost that can be done, therefore, in presenting the subjects to chemists is to try to give to them a clear picture of the general nature of the problems and of the solutions which have been found for them, without attempting to display the intermediate stages of the work.

Under these conditions, it is no serious reflection upon the authors of this monograph to say that Prof. Bohr has achieved a greater measure of success in the difficult, if not almost hopeless, task of explaining his theories to readers who are unable to understand the arguments on which they are based. This monograph is, however, much more experimental in character than Bohr's "The Theory of Spectra and Atomic Constitution," and is liberally provided with photographic reproductions of spectra of the most diverse types; indeed, in the matter of successful illustration this book may be compared with the publications of Prof. R. W. Wood, some of whose photographs are reproduced in the present volume.

As a general conclusion it may be said that the authors of the monograph have rendered a valuable service to chemists by bringing together so much information in reference to spectroscopy; but that they have probably overrated the mathematical and physical equipment of their readers. The result is that even a physical chemist, with a keen interest in spectroscopy, is likely on reading this book to feel that he is being carried—no doubt by highly competent swimmers—into rather deep water, where he is only occasionally allowed to touch bottom, or to exercise his own limited powers of swimming.

(2) Prof. Kraus deals with a subject with which physical chemists are much more familiar. His book professes to cover the properties of electrically conducting systems in general; but, in actual fact, metallic conductivity and gaseous conductivity occupy so small a portion of the volume that the monograph is really concerned only with liquid electrolytes, although it contains a final chapter on "The Properties of Metallic Substances."

Earlier writers on electrolytic conductivity, especially those of the German school, have erred in paying attention almost exclusively to aqueous electrolytes. This inevitably leads to a distorted view of the phenomena, since properties which are quite exceptional are accepted as normal if they happen to exist in aqueous solutions. Prof. Kraus, as a distinguished research-worker in the field of non-aqueous solutions, is particularly well qualified to give a broader view of the phenomena. His presentation of the subject, therefore, leaves the reader with the feeling that, under the guidance of the author, he has surveyed the whole width of the field, instead of being conveyed across it on a narrow stream of conductivity-water with such high banks that the greater part of the field is shut out from his view.

(3) Mr. Alexander's book on "Glue and Gelatin" is, in the opinion of the reviewer, of a much lower standard than the two preceding volumes. The author has already written a book on "Colloid Chemistry," but is not well known to English readers. From the book itself it is difficult to know whether the author is a colloid-chemist who has taken an interest in the manufacture of glue, or a glue-chemist who has taken an interest in the theory of colloids. In any case the monograph lays itself open to criticism by the fact that it is neither a complete technical handbook nor a satisfactory theoretical treatise.

It is indeed difficult to picture the mental attitude of the author of a technical work who finds it necessary to warn his readers of the importance of possessing "minds flexible enough to fit all the facts of Nature": or of the writer of a book on glue who proceeds to inform his readers that "the decimal in the atomic weight of hydrogen 1·008 represents electrons." Although the work contains a considerable amount of information, as well as many quotations from papers to which references are given, it is very badly put together. In this case at least the American Chemical Society has made itself responsible for a work which ought to have undergone drastic revision before being issued.

(4) Dr. Falk's book on "Catalytic Action" has not been written under the authority of the American Chemical Society, although it is issued by the same publishers, and it differs in style from the monographs reviewed above only in the absence of the Society's imprint and general introduction. Dr. Falk has recently published a book on "Chemical Reactions" in which he lays stress on the formation of intermediate addition-compounds; he represents these by enclosing the formulæ of the reacting substances in large square brackets, similar to those used by Werner to represent co-ordinated complexes. The present volume is in the main an interpretation of the phenomena of catalysis on the basis of this theory.

The theory itself lacks the preciseness of Werner's theory of co-ordination, and does not lead to any marked simplification of the task of explaining the phenomena of catalysis. In this respect it is indeed less helpful than the crudely mechanical theories of adsorption which have so clearly proved their utility in recent years, and are described in the tenth chapter of this monograph. The author states in his preface that he has not attempted to cover the whole field of catalytic reactions, but has discussed only sufficient cases to illustrate his own particular point of view. Since this point of view is not especially helpful, the ordinary student would probably be well advised to use a text-book written from a less specialised aspect; but research-workers on catalysis may well find fresh inspiration in a novel way of looking at familiar facts.

Characters and History of the Ferns.

The Ferns (Filicales) Treated Comparatively with a View to their Natural Classification. By Prof. F. O. Bower. Vol. 1: *Analytical Examination of the Criteria of Comparison.* Pp. x+359. (Cambridge: At the University Press, 1923.) 30*s.* net.

THE publication of the present volume is of peculiar interest to all who seek to understand the inter-relationships of living organisms. Consisting, as it does, of some 360 pages of beautifully produced and liberally illustrated matter, this book is indeed a literary effort of which both author and publishers may well be proud.

It has been Prof. Bower's intention to present not only a reasoned statement of the relative value of the criteria on which the systematic grouping of the ferns must for long be based, but also to indicate for them probable relationships with other primitive phyla, and thus to render the comparative study of their phylesis contributory to still wider views on the descent of land-living organisms. The present volume deals primarily with the criteria of systematic comparison themselves. Presenting as it does for the first time in the history of the literature of plant-systematics a fully co-ordinated and closely reasoned statement on the values ascribed to the characters considered, it forms a conspicuous landmark in the progress of systematic thought and writing.

On the criteria drawn from the widest study of external form, cellular segmentation, leaf venation, the vascular system of the shoot, dermal appendages, the position and structure of the sorus, indusial protections, the characters of the sporangia and spores, spore-output, the morphology of the prothallus, the position and structure of the sexual organs, and the embryology of the sporophyte, the author's rebuilding of the systematics of the ferns in the second volume will largely rest. It is not too much to say that in this book Prof. Bower has valiantly endeavoured to formulate anew standards of phyletic comparison whereby a new and more reasonable order will arise out of the chaos to which fern-systematics had been reduced. A chapter is devoted to each criterion considered, and a comprehensive and carefully chosen bibliography is in each case appended, chosen with the author's full knowledge of the literature of his subject.

Varied as are the ways whereby we arrive at our conclusions, our most absorbing interest, and indeed our ultimate aim in the study of living organisms, lie in the determination of their inter-relationships. It is safe to assert that for the past generation the only method open for a reasonable understanding of the phylesis of any group of organisms has been the morphological method. This Prof. Bower has followed with admirable persistency and foresight throughout a lifetime of active research. That the results have fully justified the means cannot for a moment be doubted. To arrive at a reasonable grouping of the ferns from the comparative study of their characters of form, structure, and reproduction has been the avowed aim of the author for many years. That the meaning of the characters themselves expressed in form and structure still escapes us will be readily granted. For many who have not followed his phyletic method, the absence of a final interpretation of structural characters may seem cause for delay in the acceptance of the relative value of the characters discussed, and indeed of any wide application of the conceptions of the relative primitiveness or advancedness at which the author has arrived. Instinctively, one revolts against the idea that hairs must be the expressions of relatively primitive characters, while scales, on the other hand, are indicative of advance, even though the author has conducted with consummate skill a special pleading of the case, supported on broad grounds by the illuminating evidence of fossil-history. That primitive ferns

were dominantly hairy is universally accepted on the fossil evidence itself, but that hairiness in a living organism—which on other grounds is considered advanced—may be viewed as a relatively primitive character seems unjustifiable, especially in the absence of any intimate understanding of the meaning of either hairiness or scaliness in any living fern.

The case is similar, and indeed must be so, with all the characters concerned, considered as they are by the author on the broad basis of structural comparison alone. It is so, for example, in the consideration of the vascular system of the axis, the venation of the leaf, and the gametophytic generations; for although we are now in possession of the fullest knowledge of the distribution and structure of vascular tracts and of the organisation of the sexual generation of many ferns, we still know nothing of the meaning of conductive tissue in the ontogeny of any organism, or of the true values to be assigned to the gametophytes of any fern which may figure in a systematic discussion.

In the hands of a less skilful writer and pleader the conceptions of "biological probability" which underlie the author's treatment of structural characters might seem less alluring than they do in the pages of this volume. The weakness of the morphological method lies indeed in its inherent inability to explain the characters considered. It must always be so, until a closer co-operation has been secured and persistently maintained between morphological and physiological investigators. Its strength lies in the knowledge that for long it must remain the sole avenue to wide generalisations on phyletic relationships. To its weaknesses and to the tentativeness of the conclusions secured by morphological study alone, the author of this work is as fully alive as is any student of phylogeny who would arrive, at some distant period, by physiological inquiry at a reasonable understanding of any life-process.

The very doubts and fears which the consideration of this book must naturally arouse for those who have not employed the author's methods are, however, integral parts of its purpose. We are on the eve of new departures in morphological inquiry, in which a closer alliance between the pure physiologist and the morphologist will be secured. It is good, then, to have this treatise at this time providing the sum of knowledge in a branch of biological science so admirably condensed, and the philosophy which has grown with it so skilfully and so clearly presented. The day of the formal morphologist is past: the day of the causal morphologist is already with us. It may yet be possible to present a work in which a chapter on "the habit and habitat of ferns" will form a satisfying conclusion to the treatise as a whole, for these are the expressions of the sum of the characters with which the author has dealt so ably.

Whatever will be the fate of the classification which the second volume of this treatise is to provide, the present volume will stand as a classic in the presentation of the thought and work of a school of investigators who for a generation have made history in biological inquiry. The pages of this book should be read and re-read by every student of descent, and its matter will be undoubtedly considered as a statement of structural fact which has seldom been surpassed in the literature of the natural sciences for clarity and just judgment.

J. McL. T.

Our Bookshelf.

Contributions to Embryology. Vol. 14, Nos. 65-71. (Publication No. 277.) Pp. iii + 162 + 15 plates. (Washington: Carnegie Institution, 1922.) 3.50 dollars.

AMONG noteworthy papers on the development of the circulatory system by E. D. Congdon, H. H. Woollard, Florence R. Sabin, and others, this volume contains an important contribution by Charles A. Doan to the solution of the problem of the bone-marrow circulation. His method of investigation was general injection, under a pressure of 130 mm. of mercury, with an Indian-ink solution, of the vascular system of about forty pigeons. By this means he claims to have brought to light the existence of an extensive capillary plexus connecting the branches of the sinusoidal, venous elements, arranged in tufts, which probably form the active, functioning vascular bed of the bone-marrow.

It is suggested that the normal state of these blood-channels, which must be studied in hypoplastic marrows, is one of collapse. This view the author correlates with his conclusion that the vascular system of the bone-marrow is a closed system, and with Drinker's discriminating statement that red cells are apparently found outside the blood-stream, and enter the moving current as a result of growth pressure, but that their extravascular origin is not implied by this presentation of the facts. It is clear that the capillary system described would add to the endothelium of the larger vessels the amount represented in a close and extensive network throughout the marrow. In the light of this, Sabin's work on the origin of blood-cells in the chick embryo is reviewed. The *venous sinusoids* of the author's text are the *venous capillaries* of most other writers. There is much to recommend the new term. Another point of interest is the author's description of the relation between the vessels of the marrow and those of the periosteum, and of the compact tissue of the diaphysis.

Die Vegetation der Erde. Herausgegeben von Prof. A. Engler und Prof. O. Drude. XV.: *Die Pflanzenwelt der bolivischen Anden und ihres östlichen Vorlandes.* Von Prof. Dr. Th. Herzog. Pp. viii + 258. (Leipzig: W. Engelmann, 1923.) 27,000 marks.

THE first part of the work under notice deals with the physical geography of Bolivia, a country comprising both high Andean tableland and moist tropical forests. This is preceded by a short account of the various

botanical expeditions to Bolivia, one of the most important being that of Weddell, which led to the publication of his classical "Chloris Andina." Dr. Herzog has made two expeditions himself, and the book before us is largely based on his own extensive travels and observations.

The second part is divided into chapters dealing with the several groups and families of plants which comprise the flora. The characteristics of the formations are described and a brief account of the different ecological regions found on the west and east sides of the Cordillera and in the high Andes is also given.

In the third and largest part, the types of vegetation and the history of the flora are more fully dealt with, and throughout the book there are numerous good text figures showing the different types of vegetation from the low lands of the Gran Chaco, the eastern edge of the Cordillera, the Savanna region of Santa Cruz de la Sierra, and the vast high Andean region which has so remarkable a flora. There is also a useful short chapter on the cultivated plants of Bolivia, and three vegetation maps and plans conclude the volume. Throughout the book the author indicates the affinities of the flora to the floras of adjacent and distant countries.

(1) *A Text-Book of Dental Anatomy and Physiology.* By John Humphreys and A. W. Wellings. Pp. viii + 323. (London: E. Arnold and Co., 1923.) 16*s.* net.
(2) *A Manual of Human Anatomy for Dental Students.* By R. Bramble Green. Pp. xi + 263. (London: Benn Bros., Ltd., 1923.) 18*s.* net.

Within its necessary limitations, each of these books is admirable. Half of (1) is devoted to comparative dental anatomy, being a well-written and straightforward account of an intricate subject which may be expected to contribute considerably to the education as well as the instruction of dental students. If it fails at all it is when too great a desire for the brief and definite leads to such statements as that "the adoption of the erect attitude led to the perfecting of the hand, that marvellous piece of mechanism by which man's progress became assured, and in consequence of this came the increase in cranial capacity and intellectual development." Such a statement, moreover, does not represent current views. The less general matter is excellent.

(2) Mr. Green has filled a gap in the series of text-books. His account of the salient features of human anatomy is well arranged and well illustrated, and he has shown great discretion in necessary omissions. The ligaments called "alar or check" in the text are marked "accessory" in the corresponding figure; but mistakes are few.

Die Pfeilgifte: nach eigenen toxikologischen und ethnologischen Untersuchungen. Von L. Lewin. Pp. xi + 517. (Leipzig: J. A. Barth, 1923.) Grundzahl: 13 marks.

Dr. Lewin's monograph on arrow poisons is one which neither students of toxicology nor those who are interested in primitive science and methods of warfare and the chase can afford to neglect. Its comprehensiveness and careful attention to minute detail are such that it is not surprising to learn that it is the product of some thirty years' study and research. In an introductory chapter he surveys briefly the early use of poisoned weapons, which were well known to the ancients and may, the author thinks, go back so far as late palæolithic times, if, that is, his explanation of certain grooves in Magdalenian bone implements is correct. He then goes on to describe in detail the various forms of poison, both animal and vegetable, in use in all parts of the world, including Europe in early historic times. Not only does he deal with their preparation, but he also considers their chemical composition and gives the result of experimental observations of their effects and the length of time in which these effects are produced. Special attention has been given to the well-known Upas or Ipoh poison of the Indonesian area and the curare of South America, and in both cases interesting accounts of these poisons are quoted from early travellers.

A Naturalist in Hindustan. By R. W. G. Hingston. Pp. 292 + 10 plates. (London: H. F. and G. Witherby, 1923.) 16*s.* net.

Imbued with the spirit of Fabre, and possessing much of his ingenuity and accuracy, Major Hingston gives a fascinating account of some of the ants, spiders, and dung-burying beetles that he has watched and subjected to various experiments in a small patch of jungle in the Fyzabad district. Of the many good things that he sets before us perhaps the most interesting are his observations on the power of communication with one another that is possessed by ants, and on their sense of direction. That an individual Phidole ant having found treasure afield is able on returning to the nest to send forth direct to the treasure and unescorted an army of its fellows, compels our wonder. The author, however, shows convincingly by reference to other species how in all probability this amazing faculty has been evolved from very simple and perfectly intelligible beginnings:—guidance of one follower by actual touch along the whole route is the starting point; progress towards the complex phenomenon exhibited by Phidole depended on successive refinements of the olfactory sense. That sense of direction is possessed seems proven by the experiments cited; but "it is quite inexplicable to us."

La Chimie et l'industrie. Numéro spécial, mai 1923. (Congrès Exposition des combustibles liquides.) Pp. 852 + xcii. (Paris: 49 rue des Mathurins, 1923.) n.p.

La Société de Chimie Industrielle organised in the month of October 1922 an International Congress on Liquid Fuels, which appears to have fulfilled the objects of the Society. A very large number of scientific and practical problems, due for solution, were discussed by the members of the Congress. The results of their labours are seen in the 800 pages of this volume, which in effect becomes a text-book illustrative of current procedure in the winning and in the utilisation of liquid fuels. Much is said of the prospect of future supplies, but little can be known with certainty in view of the doubtful duration of the yield of known wells and the unknown possibility of the discovery of further oil fields. So small an area of the world has yet been surveyed, and so little is known of the origin of the various oils, that the time is not yet ripe for the formation of broad policies. A watchful, waiting attitude is the only scientific one.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Correlation of Upper Air Variables.

I DO not see that Prof. Mahalanobis (NATURE, September 1, p. 323) has given any good reason for the statement that the correlation coefficients that I have obtained from the English balloon ascents are to be taken as the upper limit of what is possible, excepting that Capt. Douglas working on a different system in one specific instance has obtained a lower value. I freely admit they may be wrong; unless one has a very large sample one always has to reckon with the casual error of a correlation coefficient, but there seems no reason why I should not equally well accept Dr. Chapman's conclusion that they are too low.

Taking Prof. Mahalanobis's equation (1) (Memoirs of the Indian Meteorological Department, vol. xxiv., pt. ii., p. 12), transposing it somewhat, and re-arranging, we get the following expression for the correction for the observational errors:

$$\frac{s_a}{s_b}\left\{r_{ax}r_{x_1y_1} - r_{ay}\right\} + \frac{s_b}{s_y}\left\{r_{by}r_{x_1y_1} - r_{bx}\right\}$$

$$+\tfrac{1}{2}\left\{\frac{s_a^2}{s_b^2}r_{x_1y_1} + \frac{s_b^2}{s_y^2}r_{x_1y_1} - 2r_{ab}\frac{s_a s_b}{s_x s_y}\right\}$$

$$-\tfrac{1}{2}r_{x_1y_1}\left\{r_{ax_1}\frac{s_a}{s_x} - r_{by}\frac{s_b}{s_y}\right\}^2$$

where x and y denote the true departures from the mean, x_1 and y_1 the observed departures, and a and b the errors.

Let us take the special case of the correlation between pressure and temperature at a fixed height between 4 and 8 kilometres. Here $r_{x_1y_1}$ is equal to 0·85 and the ratios s_a/s_x and s_b/s_y are known to have a value of about 1/5.

Substituting approximate numerical values the correction is

$$0{\cdot}20(0{\cdot}85r_{ax} + 0{\cdot}85r_{by} - r_{ay} - r_{bx}) + 0{\cdot}04(0{\cdot}85 - r_{ab}) - 0{\cdot}02(r_{ax} - r_{by})^2.$$

Owing to its comparatively high numerical coefficient the first bracket is the important one, and a negative correction requires that r_{ax} and r_{by} should be negative and r_{ay} and r_{bx} positive. I can see no reason why the correlation values should be anything but casual; they will certainly be small. Moreover, x and y are positively and highly correlated and therefore r_{ax} and r_{ay} are likely to have the same sign; so are r_{bx} and r_{by}, hence it does not seem likely that the term can supply a large correction either positive or negative.

In the second bracket the coefficient r_{ab} is certainly positive for the special case where a and b refer to the errors of temperature and pressure at about 6 kilometres height. This is apparent because y_1 is calculated by Lagrange's formula and a positive value of (a) increases the value of y_1 and therefore increases (b), but the casual error of y_1 due to faulty calibration or incorrect working up will prevent the correlation between a and b being as high as 0·85 and the term will be positive. The third bracket is the square of a small quantity multiplied by 0·02 and is insignificant. Thus it appears probable that on the whole the computed correlation coefficients are somewhat too low.

There can be no reasonable doubt that the correlation between certain variables in the upper air is very high, and any theory of the genesis of cyclones and anticyclones to be satisfactory must account for such correlation.

I should like to add that I have never thought that the seat of atmospheric disturbances was in the stratosphere, but, since upper air observations have been available, have held that the winds of the general circulation in the upper part of the troposphere are responsible for the formation and maintenance of cyclones. This fits in satisfactorily with the known variations of temperature.

W. H. DINES.

Benson, Wallingford, Berks.

Greek Orthography in Scientific Names.

IT is difficult, as correspondents in NATURE have noted, to preserve orthography in scientific names derived from the Greek. A good example of the confusion which has been allowed to become inevitable occurs in the similarity of the generic title of two very dissimilar shrubs. *Chionanthus Virginica* has been named from χιών—snow—because of the masses of white blossom it bears at midsummer; while *Chimonanthus fragrans*, flowering in midwinter, ought to be written *Cheimonanthus*, from χειμών, winter. To each of these Greek generic names a Latin adjective has been tacked, which serves to distinguish the species, but may offend the scholar.

HERBERT MAXWELL.

Monreith, Whauphill,
Wigtownshire, N.B.

X-Rays and Crystal Symmetry.

IT has long been recognised that angular measurements do not always carry one beyond a determination of the system, and that other methods of investigation are needed if the crystal is to be assigned to its class of symmetry. But different methods do not always give the same result, so that some principle of discrimination has to be adopted. In the past the principle universally applied has been that of greatest common measure, the crystal being correspondingly relegated to the highest class, the symmetry of which is common to the various symmetries observed (in most cases this leads to the lower of two observed symmetries, since the symmetry of one is generally wholly contained in that of the other). It must be noted that all class assignments are provisional and liable to modification (necessarily in the direction of lower symmetry) as new evidence is forthcoming.

The above symmetry has hitherto always been regarded as the true symmetry of the internal structure. This view has been somewhat questioned by E. T. Wherry (*Amer. J. Sci.*, 1922, vol. 4. p. 237) and repudiated by R. W. G. Wyckoff (*ibid.* vol. 3. p. 177; vol. 4. p. 469). It is much to be regretted that considerations of space prevent any discussion of Wherry's paper, for it is in many ways suggestive. The issue raised by Wyckoff is, however, more clearly defined. As a result of a renewed X-ray examination of sal-ammoniac he finds that there is no possible model which will simultaneously satisfy Tschermak's symmetry, deduced from surface studies, and the X-ray data (a model can be found to agree with either of two higher symmetries, the ambiguity arising from an impossibility of placing the hydrogen atoms on account of their small scattering power). This leads to an entirely new definition of symmetry, as being that of the constituent parts (the atoms) as revealed by X-rays. The evidence of such surface phenomena

as face development, etch figures, and the like, is discussed and finally dismissed as untrustworthy—apparently on the sole ground that some crystals are known to exhibit different geometrical symmetries when grown or dissolved under different conditions.

An examination of Wyckoff's and Tschermak's papers would seem to leave no doubt concerning an actual clash between the two symmetries, but as Wyckoff's explanation is quite unacceptable I would discuss it here and add a few suggestions, which may contribute towards an eventual solution to a problem of great complexity.

The question, whether symmetry of structure (there is no other real symmetry) can be deduced from surface observations, revolves round the following typical case, in which observations on etch figures can well be omitted, for dissolution is the inverse of growth. Among the faces exhibited by a certain orthorhombic substance are those of a right tetrahedron, sometimes but not always accompanied by those of the correlative left tetrahedron. In the former case the symmetry appears to be holoaxial, the crystal belonging to the category of enantiomorphous figures; while in the latter case the symmetry is apparently holohedral, and the crystal is identical with its mirror image. Even in the case of such apparently ambiguous evidence the crystallographer believes he can determine the correct symmetry of structure.

In any crystal having the lower symmetry, similar directions occur in sets of four, geometrically expressible as normals to a tetrahedron. This offers a simple structural interpretation of the observed fact that if the conditions at the surface are suitable for the appearance of one facet, the other three are simultaneously developed. In other words, the structure is controlling the surface. But the conditions may simultaneously be favourable for a revealment by the structure of another set of morphogenetic directions—with the production of the left tetrahedron. The definitive choice of the lower symmetry is still seen to afford a simple correlation between structure and surface. Now consider the implication of the selection of the higher symmetry, demanding the structural subsistence of similar directions in groups of eight instead of four. The simultaneous appearance of the two tetrahedra is accounted for, but not the occasional development of the right tetrahedron alone (or alternatively of a left tetrahedron alone, if this ever occurred). There is no longer any simple explanation for a tetrahedral development, as opposed to a development of four facets at one end of the crystal (hemimorphic), or of three facets at one end and the fourth at the other. The possibility of correlating form and structure vanishes just as utterly as if the crystal were bounded by an irregular or curved surface.

Now the above substance, like thousands of others, shows no trace of curvature but obeys Haüy's Laws of Symmetry and of Simple Multiple Intercepts. Some crystals are, however, known which are partly bounded by plane and partly by curved faces, and the question naturally arises whether such curved boundaries admit of a simple structural interpretation. Fortunately, the invention of the two-circle goniometer permits of the exact exploration of a curved surface, and a recent observation in the Oxford laboratory may now be put on record. A substance closely allied to the one already discussed, in addition to plane facets of negligible symmetry import, exhibits large curved tracts arranged tetrahedrally. Moreover, there are two kinds of crystal, the curved tetrahedron of one being the mirror image of that of the other. If the crystals were mixed together, they could be separated by hand. It is evident that the apparently irregular boundary of certain crystals is being reduced to the same rule of law and order as is obeyed by the plane-faced crystals of the text-books.

Such results as the foregoing are held by a growing body of X-ray workers to have no exact structural implication, being contaminated, as it were, by the non-crystalline influence of the surrounding fusion, solution, or vapour. It therefore seems desirable to press the argument home into the structure. Exactly seventy-five years ago a young crystallographer was examining a problem that had long vexed several Academies of Science. The problem had in fact been pronounced insoluble only three years previously, but the tiny tetrahedral facets, occasionally observed in certain crops of crystals and not in others (a fact I know from experience), proved sodium ammonium "racemate" to be an impostor, being in fact a conglomerate of *d*- and *l*-tartrates. In this way Pasteur showed there is something of unimpeachable integrity on the surface of a crystal: something which when properly interpreted can be made to found a new province of a science dealing with liquids and vapours.

But this is not all. A later (as also an earlier, but forgotten) advance in the classification of crystals led to the recognition that out of thirty-two classes of crystal symmetry, there are eleven enantiomorphous classes: namely, the asymmetric class of the anorthic system, the tartaric acid class of the monoclinic, the Pasteur class of the orthorhombic, and two classes in each of the rhombohedral, hexagonal, tetragonal and cubic systems. It follows indubitably that every substance which is optically active in solution belongs to one of those classes. Happily, the most important systems statistically are the first three mentioned, and a recent count has shown that some 420 structures (an isomorphous group being regarded as one structure), representing 93 per cent. of optically active substances on the crystallographic record, are thus definitely known as to their class of symmetry. There are possibly two thousand more, lying indetermined in the specimen cupboards of the chemist for want of a crystallographer on the staff to examine them. (Parenthetically, I would point out that Shearer's rule could well be tested by an X-ray examination of those substances, which in solution have a truly asymmetric configuration. If, for example, the anorthic tetrahydrated acid strontium tartrate were found to contain more than one molecule to the unit of structure —or seignette salt more than four—the rule would be infringed.)

Unfortunately the Pasteur generalisation is not applicable to all crystals, so that a careful examination of the surface, eked out by a determination of certain physical properties, is still demanded for the great majority of substances, namely, those inactive in solution and, owing to a certain limitation, those which are only active in the crystalline condition.

The above will, perhaps, be sufficient to show that surface studies lead towards a real knowledge of crystal symmetry, provided they are interpreted by the principle of greatest common measure. In individual cases the knowledge may not be complete at the outset (every determination being in a sense provisional). It may have to be modified with accretion of evidence, in which connexion it is a highly significant fact that whenever there has been such a modification in the past, as a result of a study of such structure properties as pyro-electricity or optical activity, the modification has always been towards a lower symmetry, *i.e.* towards a symmetry which experience proves might equally well have been offered (if only on one occasion) by the surface, if the crystal had been grown or dissolved under a greater variety

of conditions. On the other hand, the symmetry demanded by the X-ray work on sal-ammoniac is higher than that of the crystallographer. It is, therefore, not the crystal symmetry (the complete physico-chemical symmetry on which crystallography and its offshoot stereochemistry are based) but a pseudo-symmetry—a phenomenon with which the crystallographer is familiar in other connexions. It may accordingly well be termed X-ray symmetry, in order to distinguish it from other pseudo-symmetries.

Now, whatever may be the true cause of this X-ray symmetry, the explanation given by X-ray workers is singularly unconvincing. So far from harmonising a previously organised body of fact and interpretation of proven worth with the new results, the explanation relies wholly on the data obtained from the X-ray tube, and discounts the value of surface evidence, almost on principle—for however ambiguous surface evidence may be in certain crystals, it cannot be fairly held to apply to sal-ammoniac, in which plane faces of growth, the run of their striations, and the orientation of etch figures all demand the same class of symmetry. It is surely obvious that the real explanation must take equal cognisance of all well-established facts, including those collected by the aid of the goniometer, microscope, polarimeter, and, last but not least, the test-tube, all such facts being apparently equally precious in this province of crystal symmetry. The problem is to evaluate the results from all these instruments without unduly elevating or depressing this or that section. My own view is that the ultimate solution awaits the discovery of a new method, which shall tell us as much about the chemical aspect of crystal structure as the X-ray method does about its physical side. Thus warned, a reader will not expect too much from the following paragraphs.

As a preliminary, it seems necessary to clear up a widespread misapprehension concerning the results of X-ray investigation. It has not infrequently been stated that the recent work on organic compounds has proved the existence of the molecule in the crystalline condition. I do not know how this misapprehension arises, for a perusal of Sir William Bragg's original paper, in this domain, shows that the molecule is assumed as a working hypothesis. The real position is that the X-ray method can scarcely ever be expected to prove molecular structure. It is now generally accepted that the origin of X-rays (as also the seat of their diffraction) lies near the nucleus, and not in the few peripheral valency electrons which provide an occupation for the chemist. The X-ray method has the defect of its qualities: in revealing the atomic positions in a crystal, it ignores the molecular aspect completely. In the case of naphthalene the method reveals the presence in the crystal of pockets, each containing a mass of material having the composition $C_{20}H_{16}$ (if anything, then, in this case it reveals polymerised molecules). The interpretation naturally takes a molecular form, because any other would be chemically absurd; but so far as anything of the nature of chemical "bonds" is concerned (or of a union of certain atoms into a molecule) it is, relatively, a waste of time to appeal to the X-ray bulb. The proper appeal is to the test-tube.

A similar remark applies to the typical inorganic case of sodium nitrate. The crystal model of the X-ray analyst allows an interpretation of a structure, which has been electrically resolved into sodium and nitrate ions. But it might also be interpreted as a fine mixture of sodium, nitrogen, and oxgyen, or even as an ionised sodium nitrite plus oxygen, in which the latter strives after geometrical symmetry and succeeds. There can of course be little doubt that we are dealing with the first alternative, because it is possible to crystallise a solution to dryness, and redissolve the salt without any appreciable evolution of nitrogen or formation of nitrite. It may be added that although ionisation of a crystal salt into electrolytic parts is extremely probable, it has not yet been proved by the X-ray method (Debye and Scherrer's work on lithium fluoride being generally held, in particular by W. L. Bragg, to be inconclusive).

In this purely atomic reaction of molecular matter to X-rays (proved to the hilt by the pioneering work of Barkla and later by Moseley) there would seem to lie a possibility of obtaining a higher symmetry than by the physico-chemical method of surface studies. The rôle played by the physicist's atom in his statement of symmetry is that of a sphere. This may be true so far as X-rays are concerned, but scarcely of the crystal, for valency forces must be taken into account. The question therefore arises whether the replacement of a sphere by a humped surface (or, alternatively stated, whether a consideration of the movements of valency electrons) will serve to degrade the symmetry, not merely of the individual atoms (as it must) but also of the structure as a whole (as it might). If this is found to be the case there is an obvious explanation of a pseudo-symmetry, obtainable by the X-ray method.

An examination of this problem shows that no lowering of symmetry can result from single valencies (I have, then, no explanation to offer for sal-ammoniac), but with the double bond (the double sharing of electrons), which first becomes possible with a divalent atom, the symmetry may, indeed, be degraded, always provided that the atom occupies a "specialised" position in the structure, *i.e.* a position in which it may be the seat of centro-symmetry or intercepted by a plane or axis of symmetry. In a crystal of sodium nitrate, for example, we have probably to deal with Na^+ and NO_3^-. If the oxygen be monovalent, or divalent with the double bond lying in the basal plane of the crystal, the symmetry is still that of the atomic crystal of the physicist; but if the double bonds be arranged in a manner suggested many years ago, without any reference to X-rays, by J. E. Marsh and myself (J. Chem. Soc., 1913, vol. 103, p. 845), the NO_3^- group acquires the symmetry of quartz, and so does the crystal as a whole (the new "space group" or point system being: Fedorov, 46 *s*; Schoenflies, D_3^7). Such a crystal would be indistinguishable by the X-ray method from the atomic crystal of the physicist, but would presumably betray its lower symmetry, when allowed to grow or dissolve in its solution. A similar theoretical possibility holds, of course, with the calcite group, the extra electron given up by Ca^{++} making up the corresponding deficiency in an atom of carbon as compared with an atom of nitrogen.

The real state of affairs is evidently not as described above, for the symmetry of the calcite group and of sodium nitrate is not that of the quartz class. It does not necessarily follow, however, that the crystal is exactly as it has been left by X-ray workers. It may be a "racemic" substance, consisting of alternate basal strata of *d*- and *l*-carbonate or -nitrate groups, interlaminated by charged calcium or sodium atoms. Examination of the new model shows such a crystal to have both the correct symmetry and the same space group as the purely atomic model (Fedorov 47 *h*, Schoenflies D_{3d}^6), but with a crystallographic vertical translation equal to twice the old value. From the X-ray point of view, however, the vertical translation would be as before, for X-rays would scarcely appreciate the fact that they are dealing with enantiomorphous groups of valency electrons. The

case is not analogous to racemic acid, for there is no enantiomorphism of the grossly material nuclei or inner swarms of electrons.

It need scarcely be added that the optically active sodium chlorate (or bromate) follows the above scheme and is in agreement with recent X-ray atomic models. The instantaneous racemisation on dissolution may well be attributed to the delicate nature of a purely electronic type of enantiomorphism.

The above suggestions are possibly open to the objection that they are too elusive to be put to an experimental test. This leads me to suggest material for future investigation, which may help towards a decision. The rhombohedral dithionates of calcium, strontium, and lead are usually quoted as having four molecules of water of crystallisation, thus, $PbS_2O_6, 4H_2O$. If this is really true, it would seem to follow that the crystal unit must contain six, if not twelve or even twenty-four, molecules of the salt, and that no successful elucidation is to be expected with present-day X-ray technique. But a rhombohedral crystal with four instead of three or six molecules of water almost amounts to a contradiction in terms, and the early analyses of these salts (ignition to an anhydrous sulphate) are perhaps not conclusive. A particularly simple crystal structure is consistent with a hexahydrated salt; in fact any eventual proof of a four-unit cell would determine the water content as securely as a chemical analysis. It is therefore conceivable that the structure is modelled on the calcite pattern (four molecules to the Bragg unit) according to the following scheme :

$$\ldots [6H_2O]Pb^{++} \ldots O_3S^{-}\text{——}^{-}SO_3 \ldots [6H_2O]Pb^{++} \ldots$$

and that we shall have an X-ray pseudo-symmetry, the atomic assemblage appearing to have the symmetry of calcite, while the crystal structure has the symmetry of quartz (the crystals are optically active, but not the solution). The rhombohedral (or hexagonal ?) anhydrous potassium salt may, perhaps, follow similar lines, but the crystallography is somewhat obscure.

No good purpose would be served by following out the consequences of a deformation of the RO_3 group into lower systems of crystallisation. Nor need the case of an RO_4 group be discussed, as it does not seem to offer any likelihood of pseudo-symmetry.

As previously indicated there is no such possibility of pseudo-symmetry as the above, when no atom, ion, or molecule occupies a specialised position in the structure. None is therefore to be expected in any of the 420 optically active structures previously mentioned. In theory, then, we have here another possible way of testing the above suggestions, but practical considerations, unfortunately, rule out any likelihood that the X-ray analyst will be able to determine any kind of symmetry in such complicated compounds in the present generation. In Astbury's recent investigation of tartaric acid the symmetry had, perforce, to be assumed.

The only other possibility that has occurred to me is that the arrangement of the internal electrons (as opposed to the chemical electrons) may affect crystal symmetry ; but as it is difficult to see how this could have any physico-chemical manifestation at the crystal surface, it has not been further examined.

In conclusion, it will be realised that the work on sal-ammoniac may represent a turning point in the history of the X-ray method, for no matter whether X-ray symmetry be held to be a pseudo-symmetry or a true symmetry, the practical consequences are the same. As emphasised by Wyckoff, the X-ray analyst must henceforth look upon crystal symmetry with suspicion, and not be led astray at the outset of his interpretation. Unfortunately, this leaves him in the air so far as symmetry is concerned, and implies a revision of many past models. The symmetry of calcite, for example, from the X-ray point of view is not necessarily the symmetry of Haüy. To the crystallographer it will remain so, until such time as new evidence shall demand a lower symmetry.

The following summary may be useful. Each crystal has a definite symmetry—that of a structure of a physico-chemical order of complexity. At the present time the only way to determine this symmetry is to study the surface or make use of such a generalisation as the Pasteur principle, which has established itself on a permanent foundation. Any higher symmetries are pseudo-symmetries, and have their origin in a suppression of certain determinants. A notable example is X-ray symmetry, for it is compulsorily based on an atomic conception of crystal structure, and not on the molecular basis demanded by a wealth of chemical facts. An attempt is made to bridge the gulf between X-ray symmetry and crystal symmetry, but it is felt that the real solution is not yet in sight, owing mainly to the lack of a general chemical method of investigating crystal structure *in situ*.

T. V. BARKER.

University Museum, Oxford,
September 8.

Some Curious Numerical Relations.

IN the course of a series of computations it was noticed that the ratio of the numerical values of the following pairs of quantities is in each case an integral power of ten. This curious relation is so surprisingly exact that it seems worthy of record :

$$(h/2\pi)^2 = 1\cdot08806 \times 10^{-54} \text{ erg}^2 \text{ sec.}^2$$
$$e^3/K_0 = 1\cdot08804 \times 10^{-28} \text{ erg cm. es.}$$

$$e = 4\cdot774 \times 10^{-10} \text{ es.}$$
$$h/k = 4\cdot777 \times 10^{-11} \text{ sec. deg.}$$

$$m_0 = 8\cdot9991 \times 10^{-28} \text{ gm.}$$
$$c^2 = 8\cdot9916 \times 10^{20} \text{ cm.}^2 \text{ sec.}^{-2}$$

$$r_1 = 5\cdot30507 \times 10^{-9} \text{ cm.}$$
$$e/m_0 = 5\cdot30500 \times 10^{17} \text{ es. gm.}^{-1}$$

The symbol *es* has been used to denote the electrostatic unit of charge, r_1 the radius of the first Bohr ring in hydrogen, K_0 the dielectric constant of a vacuum, k the gas constant per molecule; the other symbols have their usual significance. The values that served as the basis of the computation were those just given for e, e/m_0, and c, and the following: h, $6\cdot554 \times 10^{-27}$ erg sec.; the faraday, $2\cdot89365 \times 10^{14}$ es. per equivalent; the volume of one gram-molecule of ideal gas at 0° C. and one standard atmosphere, 22411·5 cm.^{3} per mole; and 0° C., 273·1° K.

N. ERNEST DORSEY.

1410 H Street, N.W.,
Washington, D.C.

Lichens and their Action on the Glass and Leadings of Church Windows.

I HAVE read with great interest the paper by Dr. Ethel Mellor in NATURE of August 25 and I should like to refer to one or two points.

The paper gives the general impression that the decay of ancient stained glass is produced by the action of lichens. This has frequently been suggested, but surely the reverse is the case—the decay of the

glass is not due to the presence of lichens but the undoubted growth of lichens on it is due to, and subsequent to, the glass being decayed.

The immediate cause of decay and the formation of the characteristic pit holes is surely due to chemical and physical decomposition, and it is only when the glass is in an advanced state of decay that the lichens find in the disintegrated glass accumulated in the pits a soil suitable for their growth. (For details I would refer to an article in Nature of May 2, 1907.)

One finds, in fact, that the degree and character of the corrosion is determined by the chemical composition of the glass. The statement that the glass of the twelfth to the fifteenth century shows a slower rate of alteration than that used later needs some modification. The glass of the twelfth century was of good quality and shows little decay, but there was steady deterioration from the thirteenth to the beginning of the fifteenth century; the glass of this latter period shows the most pronounced decay. After this time the composition of the glass in general steadily improved.

The point I would particularly challenge, however, is the suggestion that windows should be treated with a liquid mastic to prevent the growth of lichens. I am not quite sure if this is intended to apply to new or old windows. If the latter, surely the remedy is a thousand times worse than the disease. If the former, I suggest that the proper way to prevent the growth of lichens is to prevent the decay of the glass which enables them to gain a foothold. That can be done only by ensuring that glass of a composition which ensures durability is used in new windows. As a matter of fact the glass used nowadays as a rule leaves little to be desired in this respect.

One further point occurs to me. I have made many analyses of medieval stained glass and I invariably find phosphates as a constituent—particularly in glass of the fourteenth century. As the glass decays this would presumably be deposited as calcium phosphate in the corrosion pits. Would this encourage the subsequent growth of lichens and account in some measure for the prolific flora described by Dr. Mellor?

Noël Heaton.

81 Queen Victoria Street, E.C.4,
August 29.

The article referred to by Mr. Noël Heaton describes the results of "one of several possible lines of research"; it shows that lichens accelerate the chemical change of the glass and lead, and exert a mechanical action on the altered glass.

Certain species of lichen are found only on unaltered glass; they do not persist, and on disappearing leave a roughened surface conformable to their own shape. On deeply corroded glass, lichen débris, not the plant, is the more frequent. Lichen physiology is a controversial subject, but the probability is that neither the calcium phosphate nor the "soil" mentioned by Mr. Heaton accounts for the flora.

References to the presence of three species of lichen on the windows of two churches are made by Fries and Nylander, and reproduced by a few lichenologues; there has been, to my knowledge, no scientific investigation of the lichen flora on church windows or of its relation to the deterioration of glass until three years ago when the research was undertaken at the Sorbonne. I cannot therefore appreciate Mr. Heaton's statement that it "has frequently been suggested" that "the decay of ancient stained glass is produced by the action of lichens." I am, however, open to correction if Mr. Heaton will give the authority for his statement.

The only modification I can make with regard to the glass of the twelfth to the fifteenth centuries is that certain glass of the twelfth century is immune, but is this not to some extent true of the glass of each century? It is reassuring to be told that "the glass used nowadays as a rule leaves little to be desired" as regards durability, when one knows that certain stained glass of so recent a date as the second half of the nineteenth century shows an advanced state of corrosion. In this case lichens have apparently played no part.

The quality of the glass is undoubtedly a factor of great importance in ensuring its durability, but it cannot prevent the growth of lichens, as some of these plants find a suitable substratum on the smooth unaltered surface of the glass. The application of a liquid mastic to exclude the lichen spores is intended for those windows difficult of access for cleaning purposes. What can be the objection to its use on old glass and not on new? The suggestion is not my own; it finds favour with one who has more than forty years' experience in the art of stained glass, medieval and modern, and has the keenest appreciation of æsthetic value.

It may be mentioned that the destructive effect of lichens on their substratum is remarkably evident on the marble statues at Versailles,—some eighteen months ago it was decided to arrest the corrosion by cleaning the marble and then treating it with a mastic.

Does Mr. Heaton use the word "disease" in its popular or pathological sense? It is to my mind as wrongly used in connexion with the corroded glass as it would be if applied to the weathering and disintegration of rocks.

Through the courtesy of Mr. J. A. Knowles, of York, I have had access to Mr. Knowles's own work and once more read Mr. Noël Heaton's papers on the composition and decay of glass. I see no inconsistency between these papers and my article in Nature of August 25.

E. Mellor.

University College, Reading.
September 15.

Painted Pebbles from the North-East Coast of Scotland.

The statement that Azilian painted pebbles do not occur further north than Basle was made by me in a review appearing in Nature, August 25, p. 276. It has been challenged and the so-called painted pebbles found by Sir F. Tress Barry on the N.E. coast of Scotland recalled. These interesting objects cannot, however, be referred to the Azilian culture, and this for two reasons, namely:

(1) They were found in connexion with and in the precincts of Broch buildings, admittedly from their archæological and faunal content of much later date. It has been suggested that the Broch had been constructed on an older Azilian settlement, but this idea is vetoed by,

(2) When the actual objects are seen and handled it is found they in no respect resemble the Azilian painted pebbles. Prof. H. Breuil, of Paris—previously a partisan of the early age for these objects—at once rejected the Azilian date on seeing the specimens. I may add that I also came to the same conclusion when I saw and handled the stones.

However, it need not be added that the above in no way detracts from the interest of these queer objects from the Broch, and the problem of their meaning and object still remains unsolved.

M. C. B.

Science and Progress in Australia.[1]

By Sir DAVID ORME MASSON, K.B.E., F.R.S., Professor of Chemistry, University of Melbourne.

AN underlying motive of all international conferences is to contribute something towards that mutual understanding—that sympathy—which alone can preserve the peace of nations; but each has also its own specific work to do. The task of the Pan-Pacific Science Congress is to discuss those scientific problems which are of special interest in the Pacific area, to direct attention to them and to lay plans for future research. It is hoped that all the participating countries may benefit; but I think there are two good reasons why Australia may look to profit most. In the first place it is here that the Congress meets and here, therefore, that its deliberations will attract most attention from the public and those higher authorities that have it in their power to aid or discourage any co-operative ventures for the public good. In the second place, Australia, in respect to scientific effort, has more to learn from the older and greater nations—from the Mother Country, from America, from Japan, from Holland—than they have to learn from her.

This island continent is as large as the United States but has a population only about one-twentieth as great. It is a continent of huge distances and vast empty spaces, held by a people of nearly pure British stock, who would not run two persons to the square mile if evenly distributed over its surface. Collected on and near its coastal fringe, they have done much to open up the resources of the land and have learnt much about its difficulties. To carry on the work towards complete development, overcoming obstacles and gradually increasing the area of settlement, is the proud ambition voiced in the nation's motto "Advance Australia." Progress, full utilisation of the great land we occupy, is a duty we owe to ourselves; but clearly our obligation is even more binding as trustees for the world, present and future.

Many things are needed to ensure successful progress —the triumphant fulfilment of Australia's destiny. Statesmanship of course; but as to that we may have faith and confidence. Man-power—a vast increase of population; and towards that end even now the efforts of our rulers here and in Britain are turned, utilising and directing hither the migration wave from an overcrowded land where food is scarce: a movement which has arisen since the War and recalls the greater hunger migrations that went to make history when the world was young. But apart from these there is a need as pressing, as fundamental, though I think it is not so generally recognised of the people. That is the need of science.

Science is nothing more nor less than the knowledge and understanding of Nature's laws. To a law of Nature there can be no exception. The apparently abnormal is seen to be normal when the laws at work are better understood. There is no happening in the Universe except in conformity with natural law. No human act can successfully run counter to it. Any such attempt is foredoomed to failure. Man cannot "fight Nature"; he can but utilise its law-governed processes, profiting by the result. There is, indeed, no true distinction between what we call "artificial" (man-made) and "natural" (Nature-made). An artificial ruby is either not a ruby at all, and therefore misnamed, or it is the outcome of Nature's edict that certain substances, raised to a certain temperature, will fuse, and, on cooling, will crystallise in a certain manner. All that the artificer has done is to gather the right materials and to adjust the environment to the necessary temperatures; and, for this last purpose, he has but utilised Nature's infallible laws of chemical combination and of energy. His ruby is, in truth, as much a natural product as those man finds ready-made in the earth. Let me cite a more important case. Sir Ernest Rutherford is commonly said to have *caused* the *artificial* disintegration of certain of the lighter atoms, such as those of nitrogen, and their partial transmutation into hydrogen atoms. He is said to have done this by bombarding them with swiftly moving alpha-particles emitted by radio-active material. The facts are true, but the common mode of stating them is misleading. Not Rutherford, but Nature, did the work; not Rutherford, but Nature, caused the result. Neither the work nor the result was new. What Rutherford did was to arrange the environment so as to render detection of the phenomena possible; then to observe and then to interpret Nature's deeds. Radium and other radio-active matter have been shooting out swift-moving alpha-particles, and these have been bombarding other atoms and causing occasional transmutations, since time was young; only we did not know of it until recently. Rutherford's discovery is one of the most important events in the history of science, and none but a man with genius such as his for searching Nature's secrets could have made it. We owe to him many other discoveries of first-rate importance and surpassing interest; but even he can do no more than study Nature, follow out her processes, and elucidate her laws.

In more obviously utilitarian fields the same story must be told. The sheep-breeder who gradually and patiently improves the quality or the quantity of his wool and thus raises the value of his flock is not the main agent in the process. He merely acts as Nature's henchman and her immutable laws of heredity do the rest. So it is with the cultivator of improved varieties of wheat—rust-resisting or what not—or of varieties of beet that provide a greatly enhanced yield of sugar.

Is all this a mere truism? I think not; for there are many signs that mankind at large does not yet realise that everything that happens in this universe is the result of the working of natural laws and that the best that man can do is to study them and turn the knowledge of them to his profit. One is tempted here to ask the old question: how many utterly futile man-made laws have been passed by parliaments, foredoomed to become dead letters or to be rescinded, because they tried to run counter to the complex and incompletely understood natural laws of economics or social science?

But, if the principle I have enunciated be a truism,

[1] From the presidential address delivered to the Second Pan-Pacific Science Congress at Melbourne on August 13.

so much the better; for so much the more readily will it be conceded that a nation's progress is dependent on its *understanding* of Nature's laws. This is science; and so much more readily will Australia realise that science is as essential as statesmanship and man-power if she is to achieve greatness.

Science, of course, is too vast a study for any but those who give their lives to it to make much headway, and even these rarely can specialise in more than one of its many branches. Nature, it is true, is one and indivisible, but her work is infinite. The more we learn of her the more we realise her unity, but the more we are forced for our own sakes to subdivide and classify science. The most learned in any branch are at best but amateurs in any other. A nation, therefore, needing science, must make liberal provision for the highest training in all its branches, and must, moreover, see to it that the resulting skill and knowledge are fully utilised for the public good.

Nature being infinite, it stands to reason that what man already knows of her—the science of to-day—is but a fraction of what man may come to know—the science of the future. Yet this small fraction is in itself stupendous. In modern times, since man learnt how best to seek new knowledge, all the great nations of the earth have contributed, and as science grew its rate of growth became accelerated. Now not a day passes without additions to every branch. Scientific education, then, must be equipped to deal adequately with all this accumulated mass of knowledge; but the universities, if equipped to do no more, will fail in their task of training competent men of science to serve their country's needs, and that country will fail in its duty to the world—the duty of contributing by research to the growth of natural knowledge. The science of to-day cannot be divorced from the science of to-morrow; the power to make new knowledge is both the final test and the reward of a scientific education.

The familiar distinction between "pure research" and "applied research" is justified in this—that, while there is no real difference in the methods employed and one may require as much skill and knowledge as the other, the aims from first to last are essentially different. The aim of any pure research is nothing more nor less than to add something new to natural knowledge in a chosen field. The investigator's reward is the joy of discovery. The aim of any applied research is to solve a particular problem, the successful solution of which promises results of direct utility to man and is therefore of marketable value. It may be that the investigator himself does not reap this tangible reward; it may even be that he is content to let it go to others; but in any case his task is that of the treasure-seeker. If he find that the expected treasure does not lie where he hoped to find it, he may follow up any other likely clue to its whereabouts, but may not turn aside tempted by mere glimpses of an unknown land. It is true that exploration there might possibly lead to valuable discoveries, but that is mere conjecture: his immediate task is to unearth the treasure he went out to seek.

Such definitely utilitarian research should require but little advocacy, for it should appeal strongly, even to the unscientific. Any one can understand something of the valuable results that would follow from the discovery of a new and successful treatment of a disease rife among men or flocks and herds, of a method of eradicating a vegetable pest or a parasite destructive of cultivated crops, of an improved process of ore treatment or of metallurgical work, or of the utilisation of some waste product of a manufacture. But not everybody can realise that all such discoveries have their foundation in pure research, that the successful quest of the obviously useful is merely the last stage of an intricate series of scientific investigations, to which many workers have contributed—mostly working with the sole object of adding something to natural knowledge. Those acquainted with the history of scientific discovery and invention know that this is true. They know, moreover, that no genuine new knowledge can properly be stigmatised as useless or "merely academic," however remote from utility it may at first appear; for, sooner or later, it will be found as an essential link in the chain of truths that leads to a valuable conclusion.

When, in 1895, Sir William Ramsay separated small quantities of a gas from the rare mineral cleveite and identified its spectrum with that of Lockyer and Frankland's constituent of the sun's atmosphere, helium, the discovery was full of academic interest but certainly did not promise to be useful. On the purely scientific side the expectations have been far more than realised, for this helium element, since its discovery in terrestrial matter, has been linked up with all that earlier and later knowledge that has culminated in the proof of the electrical constitution of material atoms, or the fundamental identity of matter and electricity—probably the most far-reaching scientific advance within our memory. But, on the utilitarian side, what could offer less promise of practical application than a gaseous element, not only scarce and costly but also absolutely inert and incapable of forming chemical compounds? Yet it was this very inactivity that soon found for it an important use and market value. For, next to hydrogen, helium is by far the lightest of all gases; and, being inert and therefore totally incombustible, it is a safe gas with which to inflate balloons and airships, while hydrogen emphatically is not. The scarcity of supply was overcome when research showed it to be present in small proportions in several natural gas springs in America, and methods were devised for separating it from its companion gases in a pure state. In parenthesis it may be said that the solution of this problem of its separation, were we to follow it out in detail, would itself be seen to have been rendered possible by a chain of earlier pure researches on the physics of the gaseous state. When war ended in 1918, large quantities of pure helium, compressed in drums, were ready in America for shipment to Europe, to be used in war balloons and air-ships. This was but twenty-three years after Ramsay's "academic" discovery of the apparently useless element in terrestrial minerals and half a century after the first observation of it as a line in the spectrum of the sun's chromosphere. The armistice came too soon for it to play its destined part in war; but the ideal inflater of lighter-than-air vessels still meets a want in times of peace, and helium is now being prepared and stored in quantity in the United States, where I understand the use of any other gas for this purpose is prohibited by law.

Such examples of the complete dependence of practical science on pure research, and of the utter falseness of the idea that any genuine contribution to natural knowledge can be inherently and permanently devoid of utility, could be multiplied indefinitely. Any nation, therefore, which aims at progress must for its own sake foster to the utmost of its ability scientific education and both pure and applied research. If further reason and, perhaps, a higher reason be wanted, no civilised nation stands alone: each owes a duty to the others to do its share in the work that is essential for the world's intellectual and material—aye, and moral—progress—the making of new knowledge of Nature's eternal truths. Nothing but extreme poverty or youthful irresponsibility could excuse a nation which, shirking this sacred duty, elected selfishly to profit only by foreign-made science; and nothing is more certain than that it would profit not at all, for it would fail through sheer inability to understand.

That, of course, is far from being the case with Australia. Young though our nation is, it is not so very poor and it certainly is not irresponsible. To make progress for itself and for the world is Australia's just ambition, and it has done much already to prove that it does partly recognise the importance and the power of science. Each State has its University, and each University seeks, within its somewhat narrow means, to excel on its science side. We have our Royal Societies and others of more specialised type, our more popular Australasian Association for the Advancement of Science, and, of more recent birth but, we hope, with a great future before it, the Australian National Research Council, with important international connexions. Each State Government maintains its own scientific activities, particularly in connexion with agriculture and mining. The Government of the Commonwealth does much for public health and for meteorology; and quite recently it has undertaken to build, equip, and maintain a Solar Physics Observatory—a very important contribution to international research. Our Governments, indeed, both Federal and State, have given many proofs that they appreciate the value of international co-operation in scientific work. But democratic governments can never go very far ahead of public opinion; and our Australian people have given no sign as yet of a general understanding of what science can do for them or of an urgent desire to put it to the test.

Here, as elsewhere, there was some war-time awakening to the potency of applied research. It resulted, in 1915, in the adoption by the Commonwealth Government of an ambitious scheme for the formation of an Institute of Science and Industry, with a statutory constitution and with ample means for carrying out investigations over the wide field of Australia's primary and secondary industries. Pending the passing of the necessary Act of Parliament, the scheme was nursed for some four years by a body of voluntary workers, who tried to make up in enthusiasm what they lacked in financial means to success. That Institute now has its statutory constitution, its powers, its director and its office staff, but it has never yet been given the promised means to build the laboratories or appoint the skilled investigators essential to its proper work. War-time awakening was but temporary. It happens that I have a personal knowledge of the history of that adventure and of the difficulties put in its way by unlooked-for opposition and growing indifference in Parliament and elsewhere. That experience has convinced me that the Australian public is still largely blind to its own interests and its duty. Time and education will bring improvement. All that has yet been done is but a beginning, holding out hope of greater achievement in the future. For real progress, Australia needs a great deal more science, even as she needs more men and women.

Let me cite briefly a few of those typical scientific problems of a practical kind which have interested the Commonwealth Institute. Few of them are peculiar to Australia. Most have their counterpart in other countries, and there is none in which we cannot benefit from the experience of one or more of the countries in the Pacific area.

The settlement of people on the land, the spread of pastoral industry and of agriculture, are seriously hampered by the aggressive character of many vegetable pests of foreign origin. One of these, the prickly pear, is estimated to be now in occupation of some 24 million acres of Australian soil, mainly in Queensland, and to be spreading at the rate of one million acres a year. Australia, indeed, owns a much larger area under prickly pear than its total area under cultivation; and there are parts of Queensland so densely covered with this pest that surveys wanted for a railway extension scheme could not be carried through it. Destruction by mechanical means or by poisons has been found too costly for general use; but the biological method of attack holds out more hope. This is based on the fact that the prickly pear, as well as other pests, has been introduced without those natural enemies, insect or fungoid, which keep it in check in its native haunts. By importing them we might eventually re-establish the balance of Nature. Obviously, no such action can be taken without proof that it is free from risk to crops or pasture; and this means prolonged research by experts. Some definite progress has already been made in this direction, but much more work is wanted.

The cattle industry is beset by many ailments, which in the aggregate cost Australia millions of pounds per annum. The cattle tick, with the related tick-fever, is responsible for untold damage, direct and indirect. Similarly, in sheep country the blowfly pest causes enormous loss, especially in some seasons. All these and many other ills are, or should be, curable; and real success with any one of them would recoup Australia for all it is likely to spend on science; but nothing can be hoped for without extensive and systematically organised research.

In quite another field large progress has already been made, which, however, should but serve as a stimulus to further work. I refer to the increase of our harvests and the extension of the area available for cultivation by the selection and breeding of new varieties of plants better adapted to local conditions. Agricultural experts tell us that an increase of one bushel per acre in the average yield of wheat would represent a gain of 2,200,000*l.*, while any considerable extension of the wheat belt in average breadth by

the introduction of more drought-resistant varieties would enormously increase the nation's wealth.

Our forests, so uniquely Australian, offer problems which cry loudly for systematic scientific work, far too little attention having been paid to some of them in the past. The admirable pioneer labours of von Mueller and of Baker and Smith have opened up an almost limitless field in the investigation of the characters and the chemistry of our forest trees. Closely related is the practical problem of the development of forest-product industries. Those who have to do with the timber industry know how much remains to be done in the systematic study of the character of the timbers, their exact classification, and the methods of seasoning and of preservation. All this is apart from, though related to, the problem of forestry proper; that is, the development of a complete organisation, scientifically controlled, for the care and upkeep of the forests, which—though wantonly destroyed in the past—may still be one of the nation's great assets.

The thorough investigation of Australian clays, with the view of the development of a ceramic industry employing native material, is another example of what may be done by applied science in the future; and here again some noted advance has already been made by the Commonwealth Institute, though it has been compelled to restrict its field of work.

There are tasks ahead, however, of perhaps more fundamental importance than any of these in connexion with the development of our country's resources and the settlement of population—tasks, moreover, called for by our obligation to contribute in our own area to man's knowledge of the earth on which he lives. I refer to the need of much more extensive, detailed, and systematically organised topographical and geological surveys than any as yet provided for. Such work would seem to require a definite scheme of co-operation between the Federal and State Governments and the institution of permanent scientific services.

In Papua and still more in the Mandate Territory of New Guinea there is urgent need for systematic scientific work, both for utilitarian reasons and because the unknown, wherever it exists, cries loudly for intelligent investigation. There are not many parts of this earth's surface that remain to-day so unexplored as does much of the interior of New Guinea, or which hold out so much promise of reward to the topographer, the geologist, the chemist, the botanist, the zoologist, and the anthropologist. The services of all these are needed as regular adjuncts to the civil administration. The work should not be left to the casual efforts of individual enthusiasts or of occasional scientific expeditions, often privately financed and undertaken more in the spirit of adventure than of true research. It needs highly trained men and systematic organisation. Most pressing of all is the need of skilled ethnological work—the study of the natives, their beliefs, thoughts, languages, customs, and mode of life, while yet it is possible; for it can be but a little while before they become sophisticated—I had almost said degraded—by contact with white man.

Australia has voluntarily undertaken a difficult task and a great responsibility in New Guinea and the adjacent islands. Its position there is that of a public trustee. Surely its most urgent duty is to make full provision for the scientific study of the land itself, its inhabitants and all that it contains. How else can it hope to succeed? How else to discharge its obligation fully to mankind? Pioneering work has been done in the past by specialists, some of them leaders of the highest repute; but the time has surely come for systematic, co-operative, and government-supported effort.

There is, then, reason to hope that the public demand for science in Australia will grow—that it has a great future before it. In building up that future on the foundations already laid, the Australian people must look for guidance and example to the greater and older nations of the earth. In this, as in all things, we turn first to that Mother Country which we still call Home. There the Royal Society, pioneer among national academies of science, has taught and practised the true gospel of the pursuit of natural knowledge for 260 years, and many younger research associations have gained world-wide repute. There also the cause of applied science has gained steadily in recent times, and is now represented by a powerful Department of Scientific and Industrial Research and by such highly endowed institutions as the National Physical Laboratory. We look also to America, where the organisation and endowment of scientific work are now on a scale that arouses universal admiration, not unmixed with envy. There Federal and State authorities, great manufacturing firms and wealthy citizens, seem to vie with one another in promoting education and research, knowing that thus the greatness of their country will be yet increased. We look to Japan—that wonderland which, in so short a span of years, has made for itself in science, as in all ways, an honoured place among the great nations. We look to Holland, ancient centre of learning and of maritime discovery, famous in the history of the Pacific, and to its splendid colonies in our tropic seas; for both Motherland and colonies are known throughout the world for what they have done and are doing for science.

Science and the Agricultural Crisis.[1]

By Dr. CHARLES CROWTHER.

IT is generally recognised that the primary causes of the present difficulties of British agriculture are strictly economic in character, and not due to any gross and general failure to apply present-day scientific knowledge to the technique of farming, although the great disparity which exists between the average production of the country and that secured by the more competent farmers on soils of the most diverse natural fertility suggests that with a higher general level of technique and education the intensity of the crisis might have been sensibly reduced. Whether it be a case of the "sick devil" or not, the agricultural com-

[1] From the presidential address delivered to Section M (Agriculture) of the British Association at Liverpool on September 13.

munity is at present in a more receptive mood towards scientific advice than at any time I can recall in some twenty years' advisory experience, and I believe the moment to be opportune for a forward movement in agricultural education, which, if wisely developed, may remove the last vestiges of opposition and establish education and research firmly in their rightful places in our agricultural organisation.

Our agricultural educational system may be likened to a pyramid with research at the apex, elementary education and general advisory work at the base, with intermediate education, higher education, and higher advisory work occupying the intervening parts. Our pyramid has grown within the last thirty years from a very modest structure of low elevation into an imposing edifice, which perhaps appeals to the mind's eye more through its height than its spread, the upward growth having taken place at a proportionately greater rate than the expansion of the base. The essential need of the moment appears to be a broadening of the base with the view of greater stability and a more effective transmission of the results of the activities of the upper portions to the maximum basal area over which they can beneficially react.

For the purposes of my survey it will be convenient to follow the customary classification of our work into research, advisory work, and teaching. Of these three divisions I propose to deal but very briefly with the first, that of research, since the potentialities of research for the advancement of agriculture are too patent to require exposition, the ultimate object of all agricultural research being the acquisition of knowledge which will enable the farmer to comprehend his task more fully and to wield a more intelligent control over the varied factors which govern both crop production and animal production.

Agricultural progress must be dependent upon research, and no phase of our agricultural educational system is so full of great promise for the future as the comprehensive research organisation, covering practically every field of agricultural research, which has been brought into existence during the past twelve years, and developed upon lines which ensure an attractive career to a large number of the most capable research workers coming out of our universities. In praising the research institute scheme, I am not unmindful of the needs of the independent research worker and the spare-time research work of teaching staffs—the type of research work to which we owe so much in Great Britain—and it is with some anxiety that I have watched the distribution by the Ministry of Agriculture of the modest resources available for the support of this class of work. I trust that my fears are groundless, but I am afraid of a tendency to deflect such resources towards the work of the research institutes, a tendency which in common fairness to the independent worker should be most strenuously resisted. With a sufficiently liberal conception of the class of work which can be effectively carried through by the independent worker, there should be no difficulty in allocating these moneys to the purposes for which they are intended.

In suggesting that, in proportion to the means available, agricultural research is perhaps more adequately provided for at the moment than other branches of agricultural educational activity, nothing is further from my mind than to imply that greater resources could not be effectively absorbed in this direction. I am guided by the feeling that a due measure of proportion should be maintained between research and the organisation behind it designed to translate the findings of research into economic practice, and to secure that each advance of knowledge shall be made known quickly and effectively throughout the industry.

It is chiefly in the latter direction that agricultural science can make an immediate and effective contribution to the alleviation of the present crisis, since agricultural research in the main does not lend itself to the "speeding-up" necessary for quick action. The same applies also to formal educational work, which must necessarily exert its influence on the industry but slowly.

The one line of approach along which agricultural science can make its influence felt quickly is that of *advisory work*, which consists in the skilful application of existing knowledge to the solution of practical problems, or at most the carrying out of investigations of a simple type, with the view of securing guidance as to the solution of the problem in time for effective action to be taken.

The root difficulty of agricultural educational propaganda in the past has been to secure a sufficiently intimate and widespread contact with the farmer, and for this purpose no agency at our command is so valuable as advisory work, since it ensures a contact with the individual farmer which is both direct and sympathetic, originating, indeed, in most cases out of a direct request for help. The difficulties in the way of extending advisory work greatly I shall turn to presently, but I wish first of all to outline some of the more immediately helpful forms of advisory work which have fallen within the scope of my own personal experience.

I will deal first with soil advisory work, being actuated by the conviction that soil investigation is the most fundamental of all forms of agricultural research. Soil factors dominate the growth of crops from germination to maturity, and must influence the utilisation of the crops by the animal, which is their ultimate destiny. In stressing the importance of soil advisory work I am not unmindful of the fact that, despite the enormous volume of investigation relating to soils which has been carried out, the task of the soil adviser still remains a very difficult one, and except in a few directions, and over a comparatively small area of the country, the interpretation of soil analytical data is rarely clear. It is a sobering thought, indeed, to recall the abounding optimism with which soil analysis was entered upon some eighty years ago, and contrast the hopes then held with the realities of soil advisory work as we find them to-day.

The initial mistake—so common throughout a large part of our agricultural investigational work of the past—lay in a failure to visualise the complexity of the problem, even with due regard to then existing knowledge. The problem was approached as if the soil were to be regarded solely as a reservoir of plant food, the capabilities of which for crop production should therefore admit of complete diagnosis by

chemical analysis. The conception is fascinating in its simplicity, and has dominated the greater part of our soil work down to the present time, repeated endeavours being made by variation in the methods and intensity of the analytical attack to improve the persistently low degree of correlation between analytical data and crop results. Parallel with this at a later date was developed the mechanical conception, which found the major part of the explanation of the differentiation of fertility in the physical properties of the soil particles, while still later soil biology has asserted its claim to provide the "simple solution." The work of recent years, however, so brilliantly led in Great Britain by Sir John Russell and his colleagues, leaves us with no excuse for such restricted conceptions of soil fertility, which must now be regarded as the index of the equilibrium established by the mutual interactions of a highly complex series of factors, the variation of any one of which may affect the interplay of the whole, with consequent effect upon the rate or character of plant growth.

The problem of fertility being so complex, one might perhaps be inclined to despair of attaining anything really effective in soil advisory work, which must necessarily be dependent upon rapid and somewhat superficial examination. Such apparently is the view held by the Ministry of Agriculture, if one may judge by the conspicuous neglect of chemical and physical science in recent extensions of advisory facilities.

My own conception, however, of the present possibilities of soil advisory work is more optimistic, and, from experience covering the most diverse parts of the country, I am confident that an extension of facilities for soil advisory work would be of immediate and progressively increasing benefit to the farmer. The real difficulty at the moment is that for large tracts of the country we lack the necessary data to enable us to determine what is the "average soil" for each particular area, and until provision is made for specific soil work in these areas, which comprise the whole of the great agricultural areas of the Midlands, our advisory work relating to this raw material of crop production must of necessity remain superficial, and only too frequently ineffective.

In no direction has the need for extended soil advisory work become more evident in recent years than in the revelation of the extent to which large areas of our soils have become depleted of lime. Cases come almost daily to our notice in which this lack of lime is clearly the chemical "limiting factor," and the annual waste due to unremunerative expenditure on fertilisers on such land must indeed be very great. In many cases, fortunately, the depletion has been detected at a stage at which it is still economically remediable, but in others, unfortunately, this is no longer the case, and unless soil-survey facilities be greatly extended, it is certain that large areas of our land must steadily fall into the latter category, with the inevitable development in the near future of a problem of such magnitude as will require national action for its solution. It is worthy of note also that this problem will probably be accentuated rather than diminished as a greater proportion of our arable land reverts to grass.

A further direction in which great scope remains for the work of the soil adviser is in the economic manuring of crops. Inadequate and improper manuring is still widely prevalent, and the annual wastage of resources thereby incurred must represent a very large sum. A considerable part of this wastage is due to the widespread use of proprietary compound manures, more often than not compounded without any special reference to the soils upon which they are to be used, or even without intelligent adaptation to the special needs of the crops for which they are supplied. It is not uncommon, indeed, to find mixtures of identical composition offered for the most diverse crops. In far too many cases also the prices charged are extravagantly disproportionate to the intrinsic value of the ingredients of the mixture, and in all these various ways costs of crop production are made higher than they need be.

Passing on from soil and manuring, we come to the sphere of seed and sowing problems, presenting obviously abundant scope for advisory work. The need for good and pure seed is axiomatic. Seed must not only be good, however, but it must also be of the right kind, sown under proper conditions and at the most suitable time, and the value of advisory guidance on these points has always been recognised, especially with reference to the choice between different varieties of each particular crop. The variety tests carried out on the various college farms and elsewhere have always proved helpful in this respect in so far as they serve to demonstrate the general characteristics of the different varieties. Whether they have been equally successful in measuring the cropping capacities of the different varieties is more than doubtful, owing to their restriction to single, or at most double, plots of a kind. This has been recognised in the more elaborate schemes devised for the purpose by the National Institute of Agricultural Botany, which it is to be hoped may furnish a practical scheme for more accurate quantitative field tests in the future.

Given good seed, the improvement of crop possible through seed selection is perhaps not in general so striking as that frequently obtainable by manuring, but it may nevertheless be substantial, especially with crops such as barley, where improvement of quality may have a special value. There is also a rapidly extending field for seed advisory work in connexion with the laying down of land to grass for varying periods.

During the growth of the crop, advisory work is largely restricted to the domain of diseases and insect pests, the ravages of which take incalculable toll of our crops. I believe science can make no more directly effective contribution towards the removal of at least the technical difficulties of the farmer than the elaboration of effective preventive measures against pests and diseases.

I must pass on, finally, to the utilisation of crop products as food for animals, the line of work with which my own personal interests and activities have always been most closely associated. Looking back over twenty years of advisory activity, I realise that the position of the adviser in animal nutrition is infinitely stronger to-day than when I first assumed the rôle.

With all the newer knowledge at his command, the adviser in nutrition can now approach his work with

far greater confidence, and evidence of the increasing practical value of his work is rapidly accumulating. This is particularly the case with advisory work in milk production, a branch of feeding which lends itself more readily than most to carefully regulated rationing, owing to the ease with which the amount of product can be determined. Much success has also been met with in advisory work in pig-feeding, and to a less extent in the feeding of cattle, the lower degree of success in the latter case being due not so much to an inferior capability of the adviser to help as to the difficulty of dispelling the tradition that beef production represents the supreme accomplishment of the British farmer, as to which there is nothing left for him to learn. The work already accomplished represents, however, but the very beginnings of economy in the feeding of live-stock, and wasteful feeding of both home-grown and purchased feeding-stuffs for lack of the necessary advisory guidance is still far too widely prevalent.

Such are only a few of the aspects of advisory work, which, if extended more widely, might exercise a very profound effect upon the economy of the industry. Such extension implies, however, greatly increased resources in men and money and more efficient means of bringing the advisory facilities to the notice of the farmer.

I am inclined, indeed, to think that a more efficient propaganda is perhaps the first need of the situation, for one finds in all parts of the country an astonishingly large number of farmers who are totally unaware of the existence of advisory facilities of any kind. A more extensive propaganda will be useless, however, unless accompanied by increased provision for advice, since the present resources are already more than fully taxed by the relatively moderate volume of calls for assistance that now arise. Most of our counties have, at present, only one agricultural adviser—some, indeed, have none—and yet this slender organisation represents in large measure the base of contact with the industry upon which the whole pyramid of our advisory and educational work rests. It is here where I see the most immediately profitable outlet for any further moneys that may be available for agricultural education in the near future.

I have already alluded to the chemical gaps in our specialised advisory organisation, and I might also have indicated the similar and even less comprehensible inadequacy in the provision for specialist advice in economics; but these are relatively small matters compared with the paucity of the less highly specialised but scientifically trained advisers of the county organiser type, whose business it should be to secure the confidence of the individual farmer by personal contact, and to render him assistance either directly in the simpler problems or, in more complex cases, with the help of the specialist staff standing behind the county staff, whereby a more widespread and real appreciation of the practical value of agricultural education and research than now prevails might quickly be developed.

A great extension of advisory work, such as I suggest, must necessarily involve heavy expenditure, and further, an exceptional measure of care in the selection of men, since in the direct approach to the farmer personal qualities may in the first instance count for more than technical proficiency. Furthermore, if the full measure of success is to be achieved, it is essential that a more closely organised and intimate contact should be established between the various units of the advisory organisation, from the research station through the scientific adviser, to the practical adviser. Our present organisation is too indefinite and too widely permissive in this respect and calls urgently for consideration by all concerned, both county authorities and advisory and research workers, with the view of more effective co-ordination and co-operative effort.

I have laid great stress upon the potentialities of advisory work as a contribution to the alleviation of the present crisis, but I cannot close without some reference to the far greater contribution to the future prosperity of British agriculture which we can make through our educational system, if wisely pursued, in the training of the farmers of the future.

The existing facilities for organised agricultural education—at least so far as universities and colleges are concerned—are adequate to deal with the numbers of students presenting themselves. There is indeed at the moment a considerable excess output of the class of student who is either unwilling or unable to take up practical farming and must needs have a salaried post.

Of more immediate concern is our comparative failure to secure for our educational courses more than a small fraction of the sons of farmers, upon whom the future of the industry will largely rest. I have testified to the greatly awakened interest in agricultural education which has been displayed among farmers in recent years, but it is yet far from having developed into a conviction that such education is to be regarded as a vitally essential part of the farmer's training. One must perhaps be content with gradual advance towards this goal by internal development, although the possibilities of more rapid advance by external pressure should not be overlooked. The enlightened landowner might exert an influence more potent perhaps than any other in filling our colleges with farmers' sons, if in letting his farms — at any rate so far as young applicants are concerned—he showed his faith in agricultural education by giving preference where possible to men who have received adequate instruction in the principles of agriculture in addition to practical experience. So long as the private ownership of land continues, the landowner will have it in his power to render in this respect the most powerful aid to the progress of agricultural education, and by action along these lines might exert more good in one year than is attainable by many weary years of propaganda.

Whatever the character of our land-tenure system of the future, it is certain that sooner or later some guarantee of efficiency for the productive occupation of land will be demanded from the would-be farmer. We cannot continue indefinitely, on one hand, to proclaim that the land is our greatest national asset, to be maintained with the help of, and in the interests of the State in a highly efficient state of productivity, while, on the other hand, the use of the land is left open to all, regardless of fitness for its effective use. This vision of farming reduced to the status of medicine and law as a close profession regulated by an entrance examination, may perhaps be stigmatised as a horrible

nightmare; but some movement in that direction I believe to be inevitable, and, with nationalisation of the land, it might well come more speedily than one would venture to contemplate. None will question, at any rate, that, should such a day arrive, education in the principles underlying the calling will loom as largely as practical training in determining the standards of admission to the use of the land.

The Structure of the Great Rift Valley.

By Prof. J. W. GREGORY, F.R.S.

THE explanation that the lake chains of East Africa lie in a system of tectonic valleys which are a continuation of the basin of the Red Sea was due to Suess (1891) in his contribution to the geological results of Teleki's expedition. Suess regarded the Great Rift Valley as made by a sudden rupture of the crust of the earth owing to contraction, as preceded by no upheaval, its age as Pliocene and Pleistocene, and the height of the land beside it as due to an uplift[1] in consequence of the rupture; and he considered that as the East African Rift Valley is bounded by block mountains and not by parallel horsts, it is different in structure from that of the Rhine. The present writer, after a visit in 1892–3 to the highest part of the Rift Valley, supported Suess's view of its formation by earth-movements due to lateral tension, but he considered that the valley had a much longer and more complex history than Suess recognised; for the Rift Valley was made by faulting repeated at intervals from at least the Oligocene to the Pleistocene, it was initiated by an uplift of a broad arch in the Upper Cretaceous, and the infall of the top of that arch was probably a consequence of the foundering of the floor of the Indian Ocean.

The Great Rift Valley in its course from Syria to Mozambique varies greatly in structure. In some places it consists of a single trench, and at others of several branches. Its structure is geographically most complex in Tanganyika Territory, where it was studied with especial care when that area was part of German East Africa. A valuable discussion of the combined topographic, geological, and geodetic researches in that region has now been prepared by Prof. Krenkel, of the University of Leipzig.[2] He shows that between the Congo and the eastern coast of Africa three great tectonic belts are now well established. That nearest the coast forms the eastern front of the main African plateau. As it is the oldest, and in the most exposed position, its structures have been obscured by denudation. Hence the determination that this mountain rampart was formed by faulting required close examination of its geology. The evidence available shows that the central part of Tanganyika Territory is traversed by a zone of fractures, which extends from Lake Nyasa to the plateau front west of Mombasa. This eastern zone consists in places of a series of step faults, but includes, as in Uluguru, some rift valleys.

The second belt is the continuation of the main trunk of the Great Rift Valley southward from Kenya Colony. It includes Lake Magadi, and forks at Lake Natron; one branch goes south-westward, and includes Lake Eyasi, and disappears near the town of Tabora. The main trunk continues southward; it is repeatedly deflected south-westward by faults parallel to those of the eastern fracture belt; it becomes indefinite after passing Kilimatinde on the railway from Dar-es-Salam to Tanganyika. There is some evidence of the extension of this fracture belt through the Ruaha valley to Lake Nyasa. The only gap still uncertain in the course of the Great Rift Valley is from the lower part of the Ruaha to near Kilimatinde.

The westernmost tectonic belt follows the western branch of the Rift Valley, and includes the Albert Nyanza and Lake Tanganyika. It forks near its southern end: one branch breaks into splinters on the southern coast of Tanganyika; the longer branch goes south-eastward past Lake Rukwa, joins the main trunk at the Ruaha valley, and continues through Lake Nyasa to south of the Zambezi, where it has been traced by Teale and Wilson. The evidence of the tectonic origin of the valley is especially clear around Lake Tanganyika, the coasts of which show complex series of faults, fault blocks, and secondary rift valleys. Many of the faults are quite modern, as some of them have dislocated recent conglomerates and have tilted some of the lake beaches. The walls of this valley, from the features noted in the original graphical description of it by Burton, are young, and, as Prof. Krenkel holds, the westernmost of the three tectonic belts is probably the youngest.

Between Suess's simple theory that the Rift Valley was formed from a single series of fractures in the uppermost Kainozoic and my more complex classification with its three different series of fractures separated by four volcanic periods, Prof. Krenkel adopts an intermediate position. He accepts two periods of faulting and three of volcanic activity for the Nyasa basin; so that his sequence of events is nearly as long as mine; but he regards all the volcanic rocks as Miocene or later. The evidence on which I referred the lava of the plains near Nairobi to the Upper Cretaceous was admittedly scanty; but that age fitted in best with the general history of that part of the world. Later a promising clue to the age of the earlier volcanic eruptions was offered by Dr. Oswald's work on the Victoria Nyanza; but the volcanic pebbles he collected in the pre-Miocene conglomerates cannot be certainly identified. It is to be hoped that some visitor to that area will make a further collection of the volcanic pebbles from these conglomerates, so that their position in the East African volcanic sequence may be determined.

The view that the Kapitian lava plains are Pliocene has been held persistently; but that view has now been conclusively disproved by fossils collected by Mr. Sikes from beds deposited in depressions in the surface of these lavas. The fossils have been identified by Mr. R. B. Newton as Pliocene, so that the lavas themselves must be Miocene or older. Their Cretaceous age

[1] [In 1891 he referred to the uprise as an *Aufwölbung*; later as an *Aufwulstung*.]

[2] Die Bruchzonen Ostafrikas: Tektonik, Vulkanismus, Erdbeben und Schwereanomalien. Von Prof. E. Krenkel. Pp. viii+184. (Berlin: Gebrüder Borntraeger, 1922.) 7s. 4d.

has recently been supported by the work of E. O. Teale and W. Campbell Smith from the Zambezi. Some lavas which these authors correlate with the Kapitian are shown to be Cretaceous; they remark (*Geol. Mag.*, May 1923, p. 228), " . . . the close similarity between the specimens from the Lupata Gorge just described, and the Kapitian phonolites, seems to afford very striking confirmation of Prof. Gregory's view that the latter are of Cretaceous age."

This evidence establishes the suggested date for the beginning of the East African part of the Rift Valley by fixing the age of the oldest associated lavas as Cretaceous. That the Rift Valley faults had begun by the Oligocene has now received further confirmation from the Gulf of Suez. In a lecture to the Royal Geographical Society in 1921 (*Geog. Journ.* vol. lviii. pp. 267-271) Dr. Hume threw doubt on the fault origin of the Gulf of Suez, and attributed it to folding. This conclusion would have been difficult to reconcile with the successive maps of the area issued by the Geological Survey of Egypt had not that Survey also published a diagram of one of its folds (Petrol. Research Bull. No. 6, 1920, before p. 1). The structure represented is what in ordinary geological nomenclature is termed a fault. In answer to Dr. Hume's view that the Gulf of Suez was formed by folding, it is only necessary to refer to the two last publications on the area by the Survey of which he is director. The valuable account of the geology of the Gulf of Suez in No. 10 of the Petroleum Research Bulletins, by Messrs. Moon and Sadek, includes two sections which illustrate the structure of the Gulf. The essential parts of these sections are here reproduced (Figs. 1 and 2). They both represent the Gulf of Suez as in a typical fault-formed valley. The second figure (after Pl. IX. D) is especially instructive, as it shows that the faults which formed the Gulf of Suez were post-Eocene and pre-Miocene. It therefore shows that the conclusion that the Rift Valley faulting began in the Oligocene, which was first based on evidence from Lake Nyasa, holds for the Gulf of Suez. A further Petroleum Research Bulletin, No. 12, has just been issued, in which part of the eastern shore of the Gulf of Suez is described. The authors, Messrs. Moon and Sadek, conclude that the position of the shore is determined by " a very important fault," and they show that the faults in this area were in part pre-Miocene and partly post-Miocene. One of the sections, Pl. I. D-H, shows a series of vertical and steeply inclined fracture planes which are marked as faults and not as folds.

Suess's view that the Great Rift Valley is tectonic in origin has been supported by an overwhelming balance of opinion; but his view that it was a sudden rupture due to the contraction of the crust has been less widely adopted than the writer's hypothesis that it was due to a series of infalls along an upraised belt. That preliminary uplift has been accepted under various names —arch, anticline, or mountain ridge along the axis of the valley—and it is consistent with the gravity survey by Kohlschütter, of the results of which an excellent summary is given by Prof. Krenkel. Tanganyika Territory is under three different conditions. Along the coast gravity is in excess. The central area, along the south-western branch from the Great Rift Valley through Lake Eyasi to Tabora, includes a broad basin, with gravity less than the normal. Along the western branch of the Rift Valley is a long narrow band in which the gravity is also less than normal; Krenkel describes it as a *Dichterinne* or density-trough.

The majority of recent authors have adopted the view that the Great Rift Valley was due to lateral tension. That the faults which bound the valley might be due to compression has been several times suggested. The occurrence of reverse faults in the older rocks beside the Great Rift Valley appeared to support this possibility. This view was suggested by Uhlig in 1907, but he has abandoned it. An overthrust fault—which has since been rejected—was described from German East Africa, but Suess remarked that he knew of no other anywhere along the Great Rift Valley system. Dr. Hume inserted a reversed fault on the western shore of the Gulf of Suez. His section was reissued last year " slightly altered " (Petroleum Research Bulletin, Geological Survey Egypt, No. 10, Pl. VIII. Fig. 2); but the only noticeable modification, except in colouring, is that the fault is no longer drawn as a reverse fault.

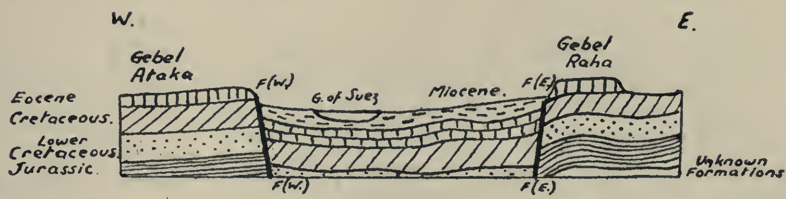

FIG. 1.—The structure of the Rift Valley of the Gulf of Suez according to the Egyptian Survey. From Petroleum Research Bull. No. 10. (Cairo, 1921.)

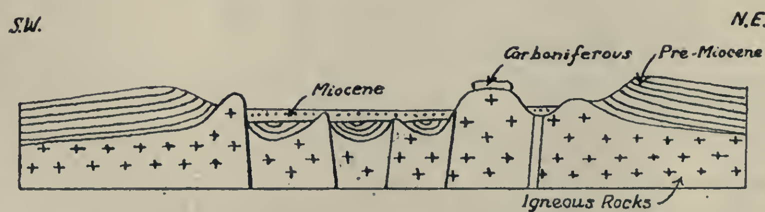

FIG. 2.—Another section by the Egyptian Survey of the valley of the Gulf of Suez. From Petroleum Research Bull. No. 10. (Cairo, 1921.)

The main advocate of the compression theory is Mr. E. J. Wayland, the director of the Geological Survey of Uganda, for the Great Rift Valley near the Albert Nyanza (*Geog. Journ.* vol. lviii., 1921, pp. 344-359). The suggestion is more probable for that area than for those places where the Rift Valley is associated with immense lava fields, and in Unyoro it has some abnormal features. Mr. Wayland's view is based on general considerations, and he does not appear to have seen any reversed fault along the Rift Valley. All the numerous faults that have been recognised in the Great Rift Valley series are normal. Any reversed faulting that may be found will probably prove to be

exceptional. The geographical and geological features of the mountains beside the Great Rift Valley resemble those of normally faulted block-mountains, and not those of fold mountains due to corrugation of the crust by compression. The topography along the Great Rift Valley agrees with that of areas torn by tension clefts rather than with mountains raised by compression; for all the faults known are normal; beside the valley rise many block-mountains and horsts, and it is associated with vast lava fields. In mountains due to compression, on the other hand, the faulting is reversed; volcanic action is rare except for isolated volcanic groups some distance from the main chain, or where it is cut across by later faults. The mountains, moreover, occur in long sinuous chains and sheaves of chains which gradually dwindle in height through parallel foothills. That the Rift Valleys are due to tension is emphatically asserted by Prof. Krenkel. The fracture zones of East Africa, he says, are zones in which the crust has been torn asunder (*Zerreissungszonen der Kruste*, p. 169).

Recent evidence, therefore, from the Zambezi and the Gulf of Suez, Mr. Sikes's fossils from the Kapiti Plains, and Prof. Krenkel's valuable monograph, combine to confirm the conclusions that the Great Rift Valley was initiated by an upbulging of the crust; that its fractures were connected with vast volcanic eruptions which began in East Africa in the late Cretaceous, and were contemporary with the Deccan Traps of India; and that one set of the fractures that made the Rift Valley happened in the Oligocene. These conclusions render it probable that the African Rift Valleys are due to the secondary consequences of the movements that made the basin of the Indian Ocean.

Obituary.

MR. F. J. H. JENKINSON, HON. D.LITT. (OXON.).

IN Mr. Francis Jenkinson, University Librarian at Cambridge, who died on September 21, has passed away one of the most versatile and distinguished of Cambridge scholars. Of his profound knowledge of classics, of bibliography and antiquarian matters, and of music, this is not the place to write. This notice must be restricted to his activities in natural science, in one branch of which, entomology, he was an expert. Nor is it possible here to give more than the briefest outline of his life. Born in 1853, he entered Marlborough at the age of twelve, and in 1872 began a distinguished career at Trinity College, remaining for the rest of his days at Cambridge. He became University Librarian in 1889, and held this post until his death, a period of more than thirty years.

Jenkinson was Curator in Zoology in the University Museum for a few months in 1878 (the same year in which he gained his Fellowship at Trinity by his classical attainments). He was the second occupant of this position, the first having been Mr. J. F. Bullar, and during his tenure he worked chiefly at insects. The same curatorship was afterwards filled (in 1890) by the late Dr. David Sharp. But though Jenkinson's official connexion with the Museum of Zoology was short, he was its valued helper to the end.

From boyhood a keen naturalist, and especially a lepidopterist, Jenkinson was much associated in early years with his lifelong friend Mr. Edward Meyrick, as a student of the smallest and most delicate forms. Some time after the coming to Cambridge of Dr. Sharp, with whom he formed a lasting friendship, Jenkinson turned his attention to Diptera. These were henceforth his special study until the last, and it is as a dipterist that he will be remembered in entomological circles.

It is true of Jenkinson's entomological side, as perhaps of all his interests, that his published works are little in comparison with the greatness of his knowledge. His writings comprise some twenty-seven short notes and papers, contributed to the *Entomologist's Monthly Magazine* between 1886 and 1922. The first four, up to 1900, deal with Lepidoptera, the remainder almost entirely with Diptera. In his longest paper (1908) he recorded a number of fungus-gnats new to Britain and described one new to science. The short notes contain records of captures and observations of the habits of various flies. His last entomological writing (1922) was an obituary notice of his old friend A. B. Farn.

But these publications are only a small part of Jenkinson's dipterological work. None could be more generous than he in aiding other workers. He had a wonderful faculty for distinguishing obscure species in the field, and very great deftness in capturing minute insects, even without a net. He was a very skilful manipulator, and collected a vast amount of material in several parts of Great Britain, but especially in his own garden at Cambridge. The pick of these captures was always at the disposal of the University Museum, to which he gave hundreds of specimens, and he was one of the makers of the Cambridge collection of British Diptera, now one of the largest extant. The national collection at South Kensington has also been enriched by many of his specimens. His miscellaneous captures in other orders were frequently interesting: a minute Copeognathe found in a house at Crowborough, and described by Dr. Enderlein in 1922 as a new genus and species (*Pteroxanium*), is the first Psocid (*sens. lat.*) with scale-covered wings to be discovered in Great Britain, the forms related to it being tropical.

Jenkinson's faculties for observing were extended to plants, birds, and even, at one time, to mollusca. He applied his classical and bibliographical knowledge also to entomological matters. The former was often called into play in questions relating to scientific names. What he wrote of Farn was true also of himself: "he disliked slovenliness" and "was the most scholarly of naturalists." As Librarian he was always sympathetic to the needs of entomology, and contributed to the result that the University Library and departmental libraries together now contain a body of entomological literature (especially periodicals) probably unsurpassed in any centre in Great Britain outside London. In person he was tall but of almost fragile build, and he was always hindered by poor health. The kindest-hearted of men, his personality exercised a singular charm over his many friends.

H. S.

Current Topics and Events.

The report of the Broadcasting Committee appointed on April 24 by Sir William Joynson-Hicks, then Postmaster-General, has now been issued, together with a statement from the present head of the Post Office, Sir Laming Worthington Evans. The committee had to consider : (*a*) Broadcasting in all its aspects ; (*b*) the contracts and licences which have been or may be granted ; (*c*) the action which should be taken upon the determination of the existing licence of the Broadcasting Company ; (*d*) uses to which broadcasting may be put ; and (*e*) the restrictions which may need to be placed upon its user or development. The Committee states that broadcasting is of value for instruction and entertainment and has great potentialities, and it is recommended that a Broadcasting Board should be established by statute to advise the Postmaster-General, though broadcasting services should remain in the hands of non-Government bodies working under Government licence. The revenue required to maintain broadcasting services is to come mainly from the receiving licence fee. The Committee considers that the existing fee of 10*s*. a year is sufficient for the present, and that three-quarters of the receipts might go to meet the costs of broadcasting. As regards licences, a uniform and simple type of licence obtainable without formalities and with practically no limitations on the apparatus is suggested for all users. Extension of broadcasting hours and of the wave-lengths in use (350-425 metres) so as to cover the range 300-500 metres, excluding the band 440-460 metres, is also recommended. The Committee considers the immediate application of its scheme desirable, and suggests that the British Broadcasting Company's licence be continued and extended on a modified basis. No recommendation is made on the subject of the protection of British apparatus against foreign competition, the Committee stating that the matter should be dealt with by Parliament.

Arising out of our recent article on "Inventors and Patents" (Nature, September 8, p. 349), it has been brought to our notice that the interest of patentees and inventors has been made the special aim of the Institute of Patentees (Incorporated). This association was founded in the year 1919, and within a short space of time enrolled some twelve hundred members. It has set up a body of technical advisers to assist the inventor and prevent him from wasting money on useless propositions. In the case, however, of those inventions which contain germs of value, even though the inventions are but crudely presented, the Institute advises their originators as to the best method of developing their productions. To a certain extent, the Institute also acts as a clearing-house, at the same time aiming at submitting to manufacturers such inventions only as have reasonable commercial prospects. In favourable cases, assistance will be given in the direction of obtaining capital for the exploitation of inventions. In order to reduce considerably the huge expense generally involved in the settlement of disputes proceeding from inventions, a Court of Arbitration has been constituted to which contentious questions may be remitted. At the present time, the Institute is concentrating its efforts on securing an Empire patent, whereby the cost of protecting an invention throughout the British Empire may be materially reduced. At the general meeting in March of this year, the chairman in his presidential address announced that the Institute was recognised by the Board of Trade, and that certain inquiries addressed to that Department were referred immediately to the Institute. It is stated that the Institute is in no way a trading or profit-making concern, for the members of its various advisory and other committees give their services gratuitously. Two classes of members are enrolled. An annual subscription of two guineas secures full membership, while associate-membership for the annual subscription of one guinea is reserved for the genuinely poor inventor. Further particulars are obtainable from the organising secretary at 44 Russell Street, London, W.C.1.

Before the War, Capt. C. W. R. Knight, as a photographer of birds and their nests, was already in the front rank. Being a practised climber, he did not confine his attention to species that build near the ground, and more recently he has specialised and taken the kinematograph as well as the ordinary camera "into the tree-tops" with most successful results. On Monday last, at the Polytechnic Hall, in Regent Street, Capt. Knight used a number of his films and some lantern slides to illustrate to a specially invited audience a lecture which will be repeated daily for the benefit of the public for several weeks to come. There is no need at the present time to emphasise the usefulness of films as records of fact (in contradistinction to portrayals of fiction) where motion has to be illustrated, or the advantage of having them verbally described. Capt. Knight was able to show the climbing of woodpeckers, the rapid flight of birds of prey when catching food for their young, the plucking of the victim, its partition among the nestlings of tender age, the throwing of it whole to them to scramble for when they were older. He also showed special records of young birds exercising their wings and getting into training for flying, as well as their hesitation before they could make up their minds to launch themselves for the first time in the air. Many points of incidental interest were mentioned by the lecturer. The finding of a swift in the nest of a hobby was used as an argument in favour of the latter bird being the swiftest of our hawks. Stress was laid upon the amount of vegetable food eaten by the greater spotted woodpecker ; the writer has known of this bird taking coconut intended for tits, but Capt. Knight described the extraction of kernels from hazel-nuts fixed in the crevices of bark, after the fashion of the nuthatch. Owls were dealt with, as was the daily life of a rookery, while the rearing of young herons was considered in detail. All who are interested in British wild life should go

to Capt. Knight's lecture, for they will thus add to their knowledge besides gaining a great deal of enjoyment.

ACCORDING to the latest estimates (given in the *Times* for September 28 and 29), the loss of property in Tokyo and Yokohama due to the earthquake of September 1 is somewhat less than was at first supposed. In Yokohama, about three-fourths of the houses (including those of greatest value) were destroyed; those which remain are apparently but a fringe of small dwellings. It was on the flat levels, intersected by canals, in which the business and shopping quarters were situated, that the destruction was greatest; but on the Bluff, where the foreign merchants lived, there was also much damage done, many of the houses having fallen into the valley below. In Tokyo, out of about 335,000 houses destroyed, only 11 per cent. collapsed under the earthquake shock; the remainder were burned. It was again in the densely crowded riverside districts that the worst of the destruction took place. It has been suggested that Yokohama should be rebuilt in a safer district, but the site of the city is obviously determined by the harbour, which has not been materially damaged. Moreover, though there is no absolutely safe area in such a seismic zone, the safest for many years to come, and perhaps for several centuries, may be the epicentral area of the recent shock.

WE are glad to note that British firms are adopting more and more the principle, on the lines of many American firms, of helping their clients in every possible way—and indirectly the general public as well—by the issue of thoroughly scientific literature written by experts. A good example of this is a recent publication, "Water Treatment," by Messrs. Brunner, Mond and Co., Ltd., the well-known chemical manufacturers of Northwich, Cheshire. This booklet, which is a production of the firm's research staff, and may be obtained free of charge by writing to the above address, gives a most lucid and concise explanation of the whole principles underlying the hardness and treatment of water, especially for boiler feed purposes, and should prove invaluable to engineers and all others in charge of boiler plant. It is divided into fourteen sections, and particularly good are those devoted to the cause of hardness, the soda ash and lime treatment, and the choice and method of operation of softening plant in general. Also of great interest are the sections dealing with the more difficult aspects of water treatment, about which the average chemist is none too clearly informed, such as the presence of free carbon dioxide and sodium bicarbonate, acids, whether mineral or of the peaty acid variety, oil, and especially the removal of the last traces of magnesium, for which the use of alumino-ferric is recommended.

IN 1905 the Meteorological Office was able for the first time to make some provision for the regular investigation of the upper air over the British Isles. Investigation had previously been carried out privately, in some cases with the assistance of the British Association and of the Royal Meteorological Society. Mr. W. H. Dines, who had taken a leading part in the practical development of the investigation, agreed to supervise the work for a nominal fee and to provide, free of charge, the facilities which his residence afforded for work with kites and balloons. After 1913 Mr. Dines removed to Benson in Oxfordshire, and for the past ten years he has continued there the upper-air work which he had carried out so successfully at Pyrton Hill on the Chilterns and at Oxshott in Surrey. Largely as a result of these investigations, England has gained a position in the forefront of the investigation of the upper atmosphere. At the end of June 1922, Mr. Dines retired from active supervision of the work, although he continued generously to give facilities for investigation to be carried on at Benson. Mr. Dines's experience indicated that open country north-west of Oxford was the most suitable place for a permanent observatory, but financial reasons made this impossible; it was accordingly arranged to utilise Kew Observatory, where the disadvantage of position would be to some extent compensated by proximity to the central office and contact with other branches of meteorological work. The transfer will probably be made in a few days. The Observatory at Benson will then be closed. The regular daily reports in connexion with forecasting will be made at the wireless station at Leafield by the courtesy of the Postmaster-General, while the upper-air investigation will be continued at Kew Observatory.

GREAT activity continues to prevail on the question of the cause and incidence of cancer. The Ministry of Health has recently issued a circular (No. 426) in which the views of a committee of experts are set forth. The circular deals with the characteristic features and natural course of the disease, the extent of cancer mortality and its increase, the proclivity to cancer, chronic irritation as a determining factor in the appearance of the disease, and the diagnosis and the treatment of cancer. The statements made are in harmony with the results of modern scientific inquiry, and the circular should help to counteract a great deal of irrelevant matter which the public has been invited to accept from quacks, cranks and well-meaning persons who do not possess the requisite knowledge. Local health authorities are encouraged to deal with the cancer problem in the best interests of the community.

Die Naturwissenschaften for August 31 contains two articles by Arrhenius and by Freundlich on the life and work of Wilhelm Ostwald, who reached the age of seventy on September 2, as recorded in our issue of August 25, p. 289.

A REVIEW of the adhesives industries appears in the *Chemical Trade Journal* for September 14. The properties, composition, extraction, and sterilisation of animal glues are concisely described. Vegetable glues (*e.g.* from starch), waterproof glues, and various forms of adhesives (*e.g.* sodium silicate adhesives, adhesives from cellulose waste, liquid glues, etc.) are all treated. A solution of glue in acetic acid is the basis of "seccotine."

A review of the dye-stuffs industry of Great Britain, by Prof. G. T. Morgan, is published in *Chemistry and Industry* for September 14. In this the progress made during and since the War in the manufacture of intermediates and dyes is discussed in great detail, and the article gives a reasoned account of the present position and future prospects of one of the most important British industrial undertakings.

The autumn conference of the Textile Institute will be held at Leicester on October 18-19. The first day of the meeting will be spent at the Exhibition of Textile Machinery and Textile Fabrics which is being held in Leicester on October 10-20. On the second day, Mr. P. E. King, of the University of Leeds, will present a paper on "Artificial Silks," and later the annual Mather lecture will be delivered by Prof. J. F. Thorpe, who will take as his subject "The Application of Dyes to Fibres and Fabrics." The remainder of the meeting will be devoted to visits to works in the neighbourhood of interest to members of the conference.

The first paper-mill for producing printing paper and pasteboard from hydrophytes or water-plants on a large scale was started on September 15 in Grossenhain, Saxony. The hydrophytes (Typha, Phragmites, etc.) are made into pulp by a cheap new process of the German Hydrophyte Co., and are said to yield a good material for paper and pasteboard. The reeds grow wild in shallow waters and their removal is desirable in the interests of fishing; in Germany, therefore, as in other countries, large amounts of the raw material are to be had freely. It has been calculated that in Germany alone one million tons of dry reed material can be gathered, thus freeing for other purposes a like quantity of wood up to now used for manufacturing wood pulp and cellulose. Several further works for producing paper pulp from reeds are to be erected in Germany as well as in other countries. It is stated that the same process may also be used for bamboo and similar tropical plants.

The Gilbert White Fellowship offers an attractive programme for the present session ending January 1924. Meetings and expeditions have been arranged for most Saturdays during the winter; noteworthy events are lectures by Dame Helen Gwynne-Vaughan on "The Mechanism of Inheritance" on November 3 and by Mr. F. R. S. Balfour on "Trees and Flowers of the North-West Pacific Coast" on December 1. The Ramble Section of the Selborne Society has also issued a programme of its fixtures for the next few months (price 6d.). Numerous "rambles" of historic and literary interest are included, mostly in London and its museums. Lectures have been arranged apart from the rambles and among them are "Among the Himalayas," by Mr. F. W. Hodgkinson, on October 31; "Japan, Past, Present and Future," by Prof. Wilden-Hart, on November 7; "In Neptune's Kingdom," by Mr. F. Martin Duncan, on November 14; "Animal Disguises and Camouflage," by Mr. Wilfred Mark Webb, on November 29; and "Nature at Home," by Mr. M. A. Phillips, on December 12. Correspondence relating to the rambles, other than applications for tickets, should be sent to Mr. P. J. Ashton, 72 High Street, Bromley, Kent.

A special volume of the *Zeitschrift für Kristallographie*, comprising no less than 640 pages and numerous illustrations and plates, has been published as a testimonial to the magnificent life-work in crystallography of the founder and first editor (for over fifty volumes) of the *Zeitschrift*—Prof. P. von Groth. It consists of contributory memoirs on their most recent original researches by thirty-two authors of repute, mostly well-known contributors to the *Zeitschrift* for many years and old friends of Prof. von Groth. The two British contributors are Dr. Tutton and Mr. Barlow, the former of whom sends a thirty-five-page paper on the completion of his many years' work on the sulphates, selenates, and double salts, in the results of which Prof. von Groth had taken a very deep interest, while the latter sends a paper on the division of space in enantiomorphous polyhedra. The universal character of this remarkable birthday present—for it commemorates the eightieth birthday of Prof. von Groth, which occurred on June 23—will be apparent from the mere mention of the names of a few of the contributors from other lands. First should be mentioned Prof. Niggli of Zurich, who now acts as editor and to whom the greatest credit is due for the organisation of such a memorable testimonial to the great crystallographer; then we have memoirs from Prof. Jaeger of Groningen, M. H. Ungemach of Paris, A. Hadding of Lund, C. Leiss of Berlin, J. Beckenkamp of Würzburg, G. Aminoff of Stockholm, F. Zambonini of Turin, H. Tertsch of Vienna, F. Rinne of Leipzig, C. Viola of Parma, E. Artini of Milan, R. Scharizer of Graz, and others equally famous from almost all the greatest European centres of learning. The value of these papers alone is a noteworthy testimony to the great esteem and affection in which the recipient is held, and their publication as a common dedication at a time like the present should prove a valuable aid to international peace and goodwill. The volume is dedicated to one of the greatest of modern men of science, one of the kindliest of men, who ever gave the impulse of his encouragement and approbation to those striving sincerely and earnestly to advance the subject which he had so much at heart.

Messrs. Longmans and Co. have many science books in their new list of announcements. Among them are "The Action of Alcohol on Man," by Prof. E. H. Starling, with contributions on alcohol as a medicine, by Dr. R. Hutchison; alcohol and its relations to problems in mental disorders, by Sir Frederick W. Mott, and alcohol and mortality, by Prof. Raymond Pearl; and "Galvanomagnetic and Thermomagnetic Effects: The Hall and Allied Phenomena," by Prof. L. L. Campbell (in Monographs on Physics).

The autumn announcement list of Messrs. Methuen and Co., Ltd., contains many books of scientific interest. Among them we notice "The Principle of Relativity," by Profs. A. Einstein, H. A. Lorentz,

H. Minkowski, A. Sommerfeld, and H. Weyl, translated by Drs. G. B. Jeffery and W. Perrett, consisting of a selection of the more important scientific papers in which the theory of relativity was originally expounded; a new and revised edition of "The Foundations of Einstein's Theory of Gravitation," by Prof. E. Freundlich, translated by H. L. Brose; "Einstein's Theory of Relativity," by Prof. Max Born, translated by H. L. Brose (the book aims at giving a lucid historical account of Einstein's Theory of Relativity); "The Chemical Elements," by F. H. Loring, dealing with recent developments in connexion with the chemical elements along lines which include electron binding processes in atomic structure, in radiation phenomena, and in electromagnetic reactions (the quantum theory and the stationary states of the Bohr atom are illustrated by analogy); "Radioactivity," by Prof. K. Fajans, translated by T. S. Wheeler and W. G. King; "Crystals and the Fine-Structure of Matter," by Prof. F. Rinne, translated by W. S. Stiles (the book presents a comprehensive survey of the fine-structure of matter as elucidated by the study of crystals); "Practical Mathematical Analysis," by Prof. H. von Sanden, translated by Dr. H. Levy; "The Mechanism and Physiology of Sex Determination," by Prof. R. Goldschmidt, translated by Prof. W. J. Dakin, presenting in concise form a review of the most modern knowledge of the mechanism and physiology of sex determination, and in particular of the theories of Goldschmidt; a translation, by J. G. A. Skerl, of Prof. A. Wegener's "The Origin of Continents and Oceans"; "What is Man?" by Prof. J. A. Thomson; and "The Origin of Magic and Religion," by W. J. Perry, describing briefly the growth and spread of religion and magic.

Our Astronomical Column.

FIREBALL OF SEPTEMBER 7.—Mr. W. F. Denning writes: "About 35 descriptions of this object, which appeared about 7 h. 45 m. G.M.T., were received from Cornwall, Devonshire, and South Wales. It was of considerable size and brilliancy, and it left a trail which remained visible for 10 or 12 minutes, according to several of the observers. A number of the reports which have been received are not of any scientific utility, for they are mere descriptions of the brightness of the phenomenon without including any precise details of the position of the flight and duration. Some of the observations, however, contain all the data necessary for computing the real path of the meteor.

"The radiant point is indicated at 260°–12°, and the height from about 69 to 26 miles descending along a course 100 miles in length, at a velocity of 20 miles per second. It extended from south-west of Land's End to about 25 miles west of Lundy Island, and it lit up brilliantly the sea and coast of Cornwall in the district nearly over which the meteor descended."

PROF. LINDEMANN'S THEORY OF THE SPIRAL NEBULÆ.—The *Observatory* for September contains two articles criticising this theory, which suggested that the spirals were clouds of cosmic dust, expelled from the galaxy by light-pressure, and shining by reflected starlight. Prof. Perrine considers the idea of their shining by reflected light untenable, on the ground that at least one of them, N.G.C. 1068, has some bright lines in its spectrum, which show the same radial velocity as the dark ones; in case of reflection the latter would be double the former. Mr. A. C. Gifford notes that the presence of layers of dark obstructing matter in many of the spirals negatives the idea of reflected light from the galaxy, a point which was also made by Mr. Reynolds.

Prof. Perrine agrees with the suggestion of expulsion from the galaxy, but holds that the spirals are no longer merely dust clouds, but that a large number of stars have formed in them by condensation; they are autonomous systems, perhaps 100 light-years in diameter; the novæ in them are supposed to be similar to, but perhaps smaller than, galactic novæ; they may be caused by stars colliding with streams of cosmic dust.

Mr. Gifford notes that Lick Observatory photographs show that the number of spirals approaches a million; assuming with Lindemann that each has a mass of ten thousand suns, we obtain an aggregate mass greater than we can reasonably suppose to have been expelled from the galaxy, since it exceeds many estimates of the united mass of the galactic stars. He agrees with Perrine in supposing that the spirals contain many condensed stars, and ascribes the novæ observed to collisions of star with star.

SOLDNER AND THE GRAVITATIONAL SHIFT OF LIGHT.—Prof. T. J. J. See and others have lately asserted that J. Soldner had anticipated Einstein in 1801 in announcing the double shift of light-rays passing near the sun. R. Trumpler examines the matter in Pub. Ast. Soc. Pacific for August, and shows, as might be expected, that the double value arises solely from an arithmetical blunder of Soldner's, who was of course using the Newtonian Law. Soldner's aim was to find the deflexion due not to the sun, but to the earth. Curiously enough, a second arithmetical blunder caused his result to be ten times too great, *i.e.* 0·001″ instead of 0·0001″; both values are far too small for practical measurement.

The charge of plagiarism against Einstein is thus shown to be completely unfounded. Cavendish had investigated the shift at about the same time as Soldner, but did not get the erroneous double value. They both assumed the corpuscular theory of light. The idea that the shift was to be expected on the wave theory came much later.

STAR-GAUGES AT LUND OBSERVATORY.—Nos. 30 and 31 of the Lund Meddelanden contain some useful work on star-gauging. The first is a rearrangement of the gauges of Sir William and Sir John Herschel. They are reduced to galactic longitude and latitude, and expressed as star density per square degree in each region measured. References are also given to the sheets of the Franklin Adams chart containing the region; the greatest and least numbers per square degree are 9630 and 20.

No. 31 contains details of the star-counts made at Lund on the Franklin Adams charts. Separate figures are given for each magnitude down to the 15th and for different distances from the centre of the plate. The density per square degree in each zone is also given. It will be remembered that Chapman and Melotte published a similar study of these plates in the memoirs of the R.A.S. However, as there is room for personality in the estimates of magnitude, an independent count is quite useful. At present there is no general discussion of the results of the count, but this will doubtless follow; in the meantime the work is very serviceable for reference.

Research Items.

THE ORIGIN OF AMERICAN QUILL-WORK.—The methods of American quill-work are figured and described in the August issue of *Man* by Mr. H. Ling Roth. Mr. Ling Roth remarks that the principle of capping the quill ends over a band of weft, twined-work, or sinew, distinguishes the technique of American quill-work from that of other peoples—Tyrolese or Nepalese—who practise quill decoration. But, strange to say, the same method is used by Ainu mat-makers, and bearing in mind the ethnic connexion between north-east Asia and north-west America, he suggests that the American technique was brought from Asia, and that Americans in later times, finding that the soft porcupine tail-quills were adaptable for this form of decoration, made use of the comparatively new-found material, and gave us the much-admired quill-work ornamentation, an invention in itself of no mean order.

THE WINNEBAGO AMERICAN INDIANS.—The chief contribution to the thirty-seventh annual report of the Bureau of American Ethnology, 1915–16, published in the present year, is a monograph on the Winnebago tribe by Mr. Paul Radin. The Winnebago and closely related tribes, like the Missouri, Oto, and Iowa, certainly represent the second westward migration of the Siouan tribes. It is impossible to say when they entered Wisconsin, but if they can be identified with the builders of the effigy mounds, they came from the south or south-east. But it is remarkable, if this theory be accepted, that no effigy mounds are found in Illinois, and it may be assumed that the Winnebago developed the mound-building habit after they had reached Wisconsin; or that other types of mounds in Illinois are the work of them and kindred tribes. It is also possible that since the effigy mounds are undoubtedly associated with the clan organisation, this type of social organisation was adopted by the Winnebago only after they had entered Wisconsin. This well-illustrated monograph gives an elaborate account of the history, archæology, material culture, social customs, clan organisation, and the cults of the Winnebago.

THE THRESHER SHARK.—In *Science* of July 13 Prof. W. E. Allen gave a description of the behaviour of a thresher shark (*Alopias vulpes*), as observed by him on the coast of California. We have received from Prof. Allen another account of the same occurrence. The shark was seen in pursuit of a small fish, which it overtook, and then, turning sharply downwards and to the right, made a whip-like stroke with its long tail, almost instantly followed by another stroke; as a result the victim was badly crippled and would have been an easy prey, had the shark not been frightened off. Prof. Allen concludes that the long whip-like tail of Alopias is a highly efficient weapon for crippling its prey, and he contrasts the methods of this shark with those used by the soupfin shark (*Galeus zygopterus*), which chases a fish with its mouth directed towards the fugitive, trying to snap it up when close enough to so so.

THE PERIODICITY AND MIGRATIONS OF LOCUSTS.—In the *Bulletin of Entomological Research* for July, Mr. B. P. Uvarov discusses the habits of the swarming locust, *Schistocerca gregaria* (*peregrina*), which is the only Old World representative of the genus. The locust *Acridium flaviventre*, Burm., is regarded as no longer a distinct species but as the solitary phase of the dimorphic species *S. gregaria*. Mr. Uvarov agrees with the conclusion of Vosseler that the migration of *S. gregaria* either as nymphs or adults has nothing to do with need for food or with the search for new breeding-grounds, and a solution of the phenomenon is not yet forthcoming. Künckel d'Herculais has observed, and Vosseler has studied more thoroughly, the extremely interesting colour changes in the individuals forming migratory swarms. These changes in *S. gregaria* are very pronounced, and Mr. Uvarov believes that they are in direct physiological connexion with the maturation of the sexual products, and of the development and reduction of the fat-body. The life-cycle of this species is very poorly known and its permanent breeding-grounds and the conditions under which breeding takes place are greatly in need of study. The author's conclusion regarding two different phases of the species suggests a promising line of investigation. Opportunities should be taken during years of mass invasions to observe the conditions of existence of the migratory phase, and also during years of minimum prevalence, when the solitary phase is most likely to be met with. Observations of this kind recorded by Morstatt in East Africa suggest that the periodicity of locusts is not due to invasions from outside, but to increased local multiplication under dry conditions.

SURVEYS IN NORTH-WEST YUNNAN.—In the *Geographical Journal* for September there is published a map of part of North-West Yunnan which has been corrected by Mr. E. A. Reeves from the observations of Prof. J. W. Gregory and Mr. C. J. Gregory, Mr. Kingdon Ward, and Mr. E. C. Young. This map shows that part of the Salween River between about lat. 27° 30′ N. and lat. 26° 30′ N. is entirely unmapped. Most of the longitudes depend upon traverses and not on astronomical determinations. The altitudes along Prof. Gregory's route are based on a series of boiling-point observations.

DISTRIBUTION OF LAND AND SEA IN PAST TIMES IN AUSTRALASIA.—Now that the hypothesis of drifting continents has added a new fascination to palæogeography, geologists will find the series of maps and considerations put forward by Prof. W. N. Benson, of the University of Otago, New Zealand, of permanent value for consultation ("Palæozoic and Mesozoic Seas in Australasia," Trans. New Zealand Institute, vol. 54, p. 1, 1923). The paper is a highly interesting "attempt to trace the geographical evolution of Australasia," and the author concludes that the opening of the Cainozoic era saw Australasia broken into blocks, the various regions thenceforth having individual and not connected histories. These regions provide the geographical features traceable at the present day. Prof. Benson takes us from the Tēthys belt to the Antarctic fringe, and he even includes (pp. 46 and 48) such a detail as the evidence of glaciation on the borders of Western Australia and South Australia at the close of Cretaceous times.

THE LAVAS OF THE PACIFIC BASIN.—Dr. H. S. Washington has traced the sequence of three types of basic lavas in Hawaii in the past, and the irregular outpouring of all of these types at the present day, from the collation of a large series of analyses, mostly due to his own work, and forming a very solid contribution to petrography (*Amer. Journ. Sci.*, vol. 206, p. 465, June 1923, and vol. 207, p. 100, August 1923). It may be remembered that this indefatigable author ("The Deccan Traps and other Plateau Basalts," Bull. Geol. Soc. America, vol. 33, p. 803) has recently concluded that the marked fluidity

of basalts forming widely spread flows depends on their high iron-content, and not on temperature or water. They show, indeed, little explosive tendency. Judd and Cole (Quart. Journ. Geol. Soc., vol. 39, p. 457. 1883), discussing the prevalence of glassy products in Hawaii, laid stress on the temperature-factor; but recent experiments in the Kilauea crater do not indicate anything abnormal in this respect. Washington's analyses, like those of Cohen, show that the Hawaiian lavas are olivine-basalts and basaltic andesites, without any unusual iron-content that might render them more fluid than the materials that have given rise to plateaux elsewhere. The remarkable prevalence of basaltic glass among the Pacific lavas remains unexplained.

Cainozoic Mammalia in American Museums.—The mounting of fossil mammalian skeletons, from material that is often marvellously complete, has become a fine art in the United States, and W. D. Matthews' paper, "Fossil Bones in the Rock," in the admirably illustrated journal *Natural History* (vol. 23, 1923; American Museum of Natural History) describes the process in a specific example. We learn how the blocks of stone are removed from the quarry, how the bones are cleaned from the alluvium of the swamp that proved a grave for their first owners, and how a reconstruction is made on one side of the mounted skeleton to represent the animal in its habit as it lived. The author deals with the three forms that abound, to the exclusion of other and even neighbouring mammals, in a quarry in Early Miocene strata near Agate, Sioux County, Nebraska, where they were first discovered in 1877. The species are *Diceratherium cooki*, a dwarf par-horned rhinoceros a little larger than a pig (see also Nature, vol. 110, p. 585, 1922); *Moropus elatus*, a clawed ungulate, combining characters of the horse, the rhinoceros, the tapir, and the titanothere, and as large as a modern camel; and *Dinohyus hollandi*, the giant pig, which is the largest known entelodont, and was presumably of savage disposition. Mr. Matthews suggests that some common drinking-habit brought these three animals into association; but may we not picture the formation of an *enclave* by three communities at some attractive spot, like those indicated by C. B. Moffatt and other naturalists in the case of wild birds on coastal flats? The museum picture (p. 368) of the association is delightful. M. R. Thorpe (*Amer. Journ. Sci.*, vol. 207, p. 91, August 1923) treats of new restorations in the Yale Peabody Museum, and illustrates *Merycoidodon gracilis*, one of the oreodont ungulates, walking delicately; its larger relative, *M. cuthbertsonii*, grazing copiously; and the carnivore *Daphænus vetus*, thin-flanked and prowling. The specimens are from the Middle Oligocene White River beds of the prolific Sioux County, Nebraska. In the following number of the *Journal*, p. 229, the same author describes the progress of our knowledge of the Merycoidodontidæ from Leidy's work in 1848 onwards, and points out a number of primitive and also carnivore-like characters in the group.

Upper Air Results in Japan.—The Journal of the Meteorological Society of Japan for January contains a communication on the summary of pilot-balloon observations at Tokorozawa by Mr. Sekine. The observations were carried out at the aerodrome of the Military Aviation School at Tokorozawa, situate in 35° 48′ N. Lat. and 130° 28′ E. Long. from observations with a single theodolite and with 40 gm. balloons, from January 1921 to September 1922. The results of 81 trustworthy ascents were used to obtain the average wind velocity and the wind directions. The observations confirm the prevalence of the great westerlies at heights above 1500 m. According to the author's opinion the height of the monsoon in this region is limited to 1500 m., above which the return current prevails to 4000 m., while above this, again, the anti-trade is said to have a slight northerly component.

Resistance Glassware.—There has recently been added to the list of resistance glassware another make produced by the well-known firm of Messrs. Chance Bros. and Co., Ltd. This new British laboratory glass forms the subject of a pamphlet received from the firm stating the result of tests made on its chemical and thermal resistance at the National Physical Laboratory. Four reagents were employed to test the resistance to chemical attack, namely, steam and water at four atmospheres pressure, boiling and evaporating hydrochloric acid of specific gravity 1·15, boiling 2N-caustic soda and a mixture of 2N-ammonium chloride and (1 to 3 of water) ammonium hydroxide. The second and fourth of these reagents produced no action that could be detected. Comparative tests using another make of British resistance glass showed the new glass as distinctly its superior in resisting the action of water and steam and hydrochloric acid while it was inferior in respect to the caustic soda test, although even here it had the advantage of remaining unclouded after attack. Flasks of the new glass, filled with molten paraffin wax and plunged into water at 15° did not crack until temperatures between 210° and 240° C. were reached, being much superior to the glass selected for comparison. On these results, the new glass quite worthily takes a position among the resistance glasses of the first rank.

Radio Direction Finding by Reception.—The Department of Scientific and Industrial Research has published the first of a series of special reports dealing with the work of the Radio Research Board. The report, which is made by R. L. Smith Rose and R. H. Barfield, gives a discussion of the practical systems of direction-finding by reception. They divide the various systems of radio-telegraphic direction-finding into three distinct groups which they call the single frame coil, the Bellini-Tosi, and the Robinson systems. They first give the history of direction finders and then a simple approximate theory. They demonstrate that in all general particulars the underlying principle of the three systems is the same. It has to be remembered that a tilted wave front does not produce directional errors. A very large number of experiments were made on damped and undamped waves to find the relative merits of the three systems. The variations from the true directions given by the methods were found to be in close agreement. At night time the direction for the minimum value was not sharply defined, and so large observational errors sometimes occurred at night. The experimental results show that all existing systems give results which are practically identical with a single twin loop rotating about a vertical axis. Whatever distortion is produced in an arriving electromagnetic wave by the geographical surroundings, and whatever the cause of the variations experienced both by day and night, all the systems were affected to the same degree. An advantage claimed for the Robinson set is that it can be used in a noisy room. No experiments, however, have yet been made to determine the relative merits of the systems in this respect.

The Liverpool Meeting of the British Association.

THE meeting of the British Association which concluded on September 19 was in many ways notable, and marked the successful introduction of various changes in the local and scientific proceedings. In point of numbers it was the third largest meeting (Australia in 1914 excepted) in the long history of the Association, but the actual number of tickets taken is not the only criterion for success. Figures are, however, of some value; for one of the objects of the Association, namely, to spread knowledge of science and what it stands for, can be most successfully accomplished by an appeal to the public receiving ready response.

While the membership numbered 3296, not less than 15,000 people attended the free public lectures in Liverpool and the surrounding boroughs, while more than 7000 paid admission to the Scientific Exhibition held under the auspices of the Association in the Central Technical School on September 10-22, and this number does not include members of the Association itself, who were admitted free.

Further, the sectional meetings were almost all not merely well attended but often overcrowded, a condition which spoke well for the enthusiasm for scientific knowledge among the members, but also illustrated the attractiveness of the programmes.

The inaugural meeting, when the president delivered his address, was remarkable for the fact that the whole proceedings were broadcasted, and in two halls in Liverpool the wireless version was accompanied by lantern illustrations identical with and shown simultaneously with the originals shown during the address itself in the Philharmonic Hall. The address was well heard in most parts of the British Isles, and was even picked up so far away as Switzerland. This is, indeed, an example of the development of physical science since the last Liverpool meeting held in 1896.

The place of the customary second evening lecture was taken by a most successful scientific soirée given by the Local Committee at the University. A wonderful series of experimental and other exhibits had been arranged and a most comprehensive programme had been prepared, but unfortunately, owing to the awkward lay-out of the University Buildings, it must have been nearly impossible for very many of the large and enthusiastic gathering to see properly one-half of all the interesting things on view or to hear many of the excellent series of lecturettes. Such a soirée, however, is full of value and was greatly appreciated, and the excellence of all the arrangements at it reflected the greatest credit on all those concerned in its organisation.

A delightful reception was given by the Lord Mayor and Lady Mayoress in the splendid suite of buildings comprised by the Walker Art Gallery, Picton Reading Room, Hornby Library, and the Museum, which for the purpose were all thrown *en suite*. Seldom if ever have these rooms been seen to better advantage, and the arrangements for dealing with such a large gathering left nothing to be desired.

Important points in the work of the various Sections will be dealt with in special articles, but, as already mentioned, sectional activity was more pronounced than at any recent meetings.

In the physical and chemical sciences this was no doubt partially due to the presence of a remarkably large number of the most brilliant workers in these fields. With Sir Ernest Rutherford as president of the Association, Prof. McLennan as president of Section A, and Prof. Donnan of Section B, and the presence of Sir William Bragg, Sir Oliver Lodge, Profs. Bohr, Langevin, G. N. Lewis, Coster, Hevesy, and a host of other well-known names, these Sections could scarcely fail to be of unusual importance and interest. Indeed, Sections A and B represented an extraordinarily representative gathering of the great men of all countries. Other sections were equally happy in the importance of the subjects they presented, and possibly to the lay mind proved an even greater attraction than the recent developments of atomic theory and the electrical constitution of matter.

It was most satisfactory to find the true scientific interest of the meeting as undiminished as in pre-War years, and this Liverpool meeting a worthy successor to the very successful one of a quarter of a century ago.

The fifty-five general and sectional excursions arranged this year were all well patronised, the number of applications for many exceeding the possible number for the excursion. As practically all the excursions at this meeting had a more or less definite scientific interest as distinct from mere picnics, it is clear that members are as keen to follow science afield as in the lecture room.

At the close of the meeting a party went for four days on a visit to the Isle of Man. Granted good weather they should have seen all that is most interesting in the Island to archæologists, geologists, botanists, and marine biologists.

In conclusion a word must be said about the Reception Room. Few cities possess a hall at once so commodious, convenient, or beautiful as St. George's Hall. The fine tessellated floor (unknown to most even of Liverpool citizens, since it has not been on view for nearly twenty years) was greatly admired, and with the comfortable furnishing and floral decorations made a charming central meeting-place for members. The Reception Room was rarely empty, and helped in no small measure the success of the meeting by forming a convenient and comfortable rendezvous.

The Liverpool Meeting of 1923 will certainly be handed down as one of the really successful meetings of recent years.

ALFRED HOLT.

The International Meteorological Conference at Utrecht.

SINCE the first steps were taken in 1853 towards international co-operation in meteorology, the International Meteorological Organisation has had a varied career, its meetings sometimes taking the form of congresses of plenipotentiaries appointed by Governments and convened through diplomatic channels, and sometimes of conferences of directors of meteorological services and observatories meeting without official aid.

Until 1919 the Organisation had no written constitution, but at the first Conference held after the War, at Paris in 1919, "Règlement de l'organisation météorologique internationale" was formally adopted. According to these rules the International Meteorological Organisation comprises: (1) Conferences of Directors; (2) the International Meteorological Committee; (3) Commissions. The Conferences are to meet every six years and to consist of "all heads of Réseaux of stations in each country and the Directors of Meteorological Observatories which are official and independent of one another," to whom are added a number of directors of private institutes and representatives of Meteorological Societies.

The International Meteorological Committee is

appointed by each Conference to act until the meeting of the next Conference, and is to all intents and purposes the executive body of the Conference, for it carries out the decisions of the past Conference and prepares the business of the next. Each member of the Committee must belong to a separate country and must be the director of an independent meteorological establishment. Commissions are appointed by the Committee "to advance the study of special questions," and members are appointed simply from the point of view of their personal qualifications to assist the work of the Commission. In this way the assistance of men of science and private gentlemen unassociated with official services is made available and freely used.

When the Conference met in Paris in 1919 the political state of the world was so abnormal that invitations could not be sent to some countries, and many other countries were not able to be represented. It was therefore felt that another Conference should be called as soon as conditions became more favourable and all countries without exception could meet in council. When the International Meteorological Committee met in London in 1921 it was considered that such a time was rapidly approaching, and the invitation of Prof. van Everdingen, director of the De Bilt Observatory, Holland, for a meeting of the Conference in Utrecht during 1923 was accepted. The return to normal political relationship has not been so rapid as was expected, and the troubles of the early months of 1923 made it look at one time as if the Conference would have to be postponed, but it was finally decided not to cancel the invitations which had been despatched in December 1922, and this course has been justified by the successful meetings of the Conference held in Utrecht on September 7–14.

The meetings of the Conference were preceded and followed by meetings of several Commissions. The Commissions for Agricultural Meteorology, Solar Radiation, Terrestrial Magnetism and Atmospheric Electricity, Weather Telegraphy and Maritime Meteorology were held before the Conference (September 3–6), and the Commission for the Study of Clouds and the Commission for the Upper Air met after the Conference (September 14). For the meetings of the Commissions and Conference fifty members were present from Argentine (1), Austria (1), Belgium (2), Brazil (1), Denmark (1), Spain (2), Finland (1), France (5), Great Britain (5), India (1), Japan (4), Norway (3), Holland (11), Poland (2), Portugal (1), Russia (2), Sweden (3), Switzerland (2), Czecho-Slovakia (2).

At the first meeting of the Conference on Friday, September 7, Sir Napier Shaw (Great Britain) was elected president, and Dr. Hesselberg (Norway) secretary-general. After the president's address had been delivered and certain business matters disposed of, it was decided to remit all reports and resolutions submitted to the Conference to five sub-commissions for preliminary consideration and the preparation of suitable recommendations. This distribution occupied the greater part of the meeting on Friday afternoon, when the Conference adjourned until the following Tuesday to give the commissions time to prepare their reports. When the Conference reassembled on Tuesday it worked very hard for three days considering the sixty odd resolutions submitted for its approval.

The great development of the use of wireless telegraphy in the dissemination of meteorological data has necessitated very intricate co-operation between meteorological services all over the world, especially in Europe. As the information is distributed broadcast for the use of any one who cares to receive it, it is highly desirable that the messages issued in the various countries should be of the same form and in the same code. As the result of untiring work of the Weather Telegraphy Commission under the guidance of its energetic president, Lieut.-Col. Gold, the New International Code is now used by twenty-two meteorological services. The arrangement of the times of issue of the wireless messages to prevent interference is also a difficult matter and necessitates close co-operation. It is not surprising, therefore, that twenty resolutions were submitted to the Conference by the Weather Telegraphy Commission. These dealt with such questions as the wording and interpretation of the code, times of issue, description of the stations, reduction of pressure to sea-level, additional observations, and the establishment of sub-commissions to watch the working of the code and to study proposals for improvements. A new departure was the agreement to add a new group of figures to certain messages, to allow experiments to be made of a new method of forecasting, based on a close study of cloud forms, which has recently been developed by the French Meteorological Office. It was very gratifying that it was not found necessary to alter the International Code, for it is extremely difficult to carry through a change when so many services are concerned, and it would jeopardise all the progress made towards the use of a uniform message if changes were made by some and not by others.

The resolutions submitted by the Commission for Maritime Meteorology were less numerous, but they contained references to several remarkable advances towards the extension of synoptic methods to ships at sea. The Commission recommended the adoption of a code to be used for wireless weather messages sent out from ships. The code consists of eight groups of figures, the first four of which are called universal groups and will be the same for all ships in all parts of the world; the second four, called national groups, will be different according to the office which organises the issue, and will be designed to meet the different needs of the various services. This proposal, which was accepted by the Conference, marks a great advance in international co-operation in all parts of the world. The Conference also recorded its appreciation of the work performed on board the *Jacques Cartier*. This is a French ship which has made experiments during voyages between America and Europe of collecting meteorological information by wireless telegraphy from ships and shore, preparing a meteorological chart of the Atlantic, and then broadcasting forecasts for the use of ships. The *Jacques Cartier* carries an officer of the mercantile marine trained in the French Meteorological Office, who is assisted by a clerk lent by that office. Further developments along these lines are to be expected.

The power of the method of "correlation" when applied to meteorological data is now generally recognised by meteorologists. The success of Dr. G. T. Walker, who employs this method in his forecasts of the Indian monsoon, is well known. Such work, however, fails unless homogeneous data extending over a long period are available. Prof. Exner, of Vienna, brought this matter before the Conference, and a resolution was adopted expressing the opinion that the publication of long and homogeneous data from a number of stations at distances of about 500 or 1000 kilometres from one another would be of great value. Not content with expressing this opinion, the Conference asked Dr. G. T. Walker to supervise the working of the resolution so far as Asia is concerned, and similarly Prof. F. M. Exner for Europe, Mr. H. H. Clayton for America,

and Dr. G. C. Simpson for Africa, Australia, and the ocean generally.

The Conference was unable to solve the problem submitted to it by the Commission for the Upper Air regarding the international publication of upper-air data. That these data should be collected and published in a uniform manner is highly desirable, but all the efforts of Sir Napier Shaw, the president of the Commission, to find a possible way of doing so have been unavailing. Such an undertaking would be expensive and would require financial aid from all countries concerned. In present circumstances it is not surprising that such aid is not forthcoming, and all the Conference could do was to make suggestions for meeting temporarily the pressing need for the rapid circulation of results obtained by means of sounding balloons. The data obtained by the use of aeroplanes and pilot balloons are too numerous to be handled internationally at present, and the Conference therefore recommended that each country should publish its own data.

Many resolutions dealing with agricultural meteorology, terrestrial magnetism, atmospheric electricity, solar radiation, and the upper atmosphere were adopted, but space does not allow of further details here.

One of the most important questions dealt with by the Conference was its relationship to the International Union of Geodesy and Geophysics. The great growth of the official weather services of all civilised countries has provided so many questions of administration and organisation for international consideration, that this side of the activities of the International Meteorological Organisation has swamped the scientific side. At recent meetings of the Conference and Committee there has been no time for scientific discussion, and therefore little to attract the members of the Organisation other than those connected with the great official meteorological services. A resolution was therefore considered to alter the rules in such a way as to limit membership of the Conference to directors of meteorological services. There was practically no opposition, and the rule governing the membership of the Conference now reads as follows :—

" The Officers of the Committee shall invite to the Conference all heads of Réseaux of stations in each country which are official (d'état) and independent of one another."

It was generally understood that this would remove from the work of the Organisation all questions of pure science, and that the science of meteorology would be considered only in so far as it is applied to the needs of the meteorological services. Practically, this is no change in the work of the Organisation, but it makes a clear distinction between the sphere of the International Union of Geodesy and Geophysics and the sphere of the International Meteorological Organisation. There should now be no material overlap between the work of the Union, which considers meteorology from the scientific side, and the work of the Organisation, which " studies only those questions which are of interest to all national meteorological services and which necessitate the utilisation of their own network of stations."

At the last meeting of the Conference, when the new International Meteorological Committee had been elected and Sir Napier Shaw was about to terminate his long connexion with international meteorology, Col. Delcambre, the head of the French Meteorological Office, rose and in a short eloquent speech expressed the regard every member of the Conference felt for Sir Napier Shaw and the debt which meteorology owed to him. He then proposed that Sir Napier should be elected an honorary member of the International Meteorological Committee, an honour never before bestowed. The proposal was accepted with prolonged applause and much feeling, for all felt that this was a happy way of marking their appreciation of the great work done by Sir Napier Shaw for international meteorology.

The newly elected Committee met the next day and appointed Prof. van Everdingen president, and Dr. Hesselberg secretary. The office of vice-president was left vacant for the present.

The general feeling at the end of the meetings, frequently expressed, was that good work had been done and much progress made. Good feeling between members from all countries was very marked throughout.

The Emerald Table.

By E. J. Holmyard.

One of the most famous of alchemical tracts is the Emerald Table (" Tabula smaragdina "), ascribed to the almost mythical " founder of chemistry," Hermes Trismegistos. Not merely is it regarded as a masterpiece by the medieval alchemists themselves, but later historians of chemistry have written innumerable articles in a vain attempt to solve its perennial mystery. The Latin text of the Tabula has been printed so many times that it is unnecessary to reproduce it here; it may be seen in Kopp's " Beitr. zur Gesch. der Chemie," p. 377, while an English translation is given by Thomson in his " History of Chemistry," p. 10.

The problems presented by the Tabula are shortly as follows : (1) In what language was it originally written ? (2) What is its age ? (3) Has it anything whatever to do with alchemy ? The third of these problems need not be discussed in this place : it is sufficient to remark that it has always been considered alchemical in nature, and in that judgment we may reasonably acquiesce.

The question of the age of the work needs a fuller treatment. It was first printed at Nuremberg in 1541, under the title " Hermetis Trismegisti Tabula smaragdina, in ejus manibus in sepulcro reperta, cum commentatione Hortulani," but according to Kircher (" Oedipus Aegyptiacus," 1653, II. ii. p. 428) it is mentioned by Albertus Magnus in his " Liber de secretis chymicis," which is, however, probably spurious. Kriegsmann (" Hermetis Trismegisti . . . Tabula smaragdina," 1657) maintained that the work was originally written in the Phœnician language, and says that, according to some, the Emerald Table was taken by a woman called Zara from the hands of the dead body of Hermes in a cave near Hebron. Other authors inform us that Alexander the Great, on one of his journeys, discovered the sepulchre of Hermes and in it the tract inscribed upon a table of emerald. These obviously legendary accounts led many historians of chemistry to doubt the great age of the Tabula, and Thomson (*op. cit.* p. 13) says that " it bears all the marks of a forgery of the fifteenth century." Kopp, however, showed that it was well known to European alchemists in the middle of the thirteenth century, and that it was mentioned by Albertus Magnus (1193–1282) in a work which is

undoubtedly authentic, namely, the "De rebus metallicis et mineralibus" (lib. 1, tract. 1, cap. 3). The commentary on the Tabula by Hortulanus, to which reference has already been made, might be used to show an even greater antiquity, if Hortulanus were safely to be identified with John Garland (1202–1252), but this identity is open to grave doubt.

The last word on the subject was that of Prof. E. O. von Lippmann, in his admirable book "Die Entstehung und Ausbreitung der Alchemie" (Berlin, 1919, p. 58): "Ein griechisches Original der 'Tabula smaragdina' ist nicht bekannt, und da die syrischen und arabischen Chemiker ihrer überhaupt keine Erwähnung tun, so bestehen berechtigte Zweifel an ihrem vorgeblichen Alter; so alt wie der gesamte zugehörige Litteraturkreis könnte sie aber dem soeben Ausgeführten zufolge immerhin sein, und die Anführung des Hermes Trismegistos, sowie die Herübernahme des im Lateinischen ganz ungebräuchlichen Wortes *telesmus* (τελεσμός) lassen eine Übersetzung aus dem Griechischen mindestens als möglich erscheinen." In short, although the earliest definite mention of the Tabula is that made by Albertus Magnus, there is a possibility that the claim of the alchemists, namely, that it was translated from the Greek, was well founded.

The following observations, therefore, would appear to be of considerable interest, as throwing further light upon both the age of the Tabula and the language in which it was written. The celebrated Jābir ibn Ḥayyān, who flourished in the last half of the eighth century A.D., wrote a very large number of books on alchemy, a partial list of which is given by Al-Nadīm in his encyclopædia, the "Kitāb al-Fihrist" (tenth century A.D.). This list was compiled partly from Jābir's own catalogue of his writings, and there seems to be no doubt of its authenticity, especially as about fifty of the books mentioned are still extant. The first book on the list is one entitled "Kitāb Usṭuqus al-Uss al-Awwal," a title which Berthelot ("La chimie au moyen âge," iii. 32) translates "Le livre d'Estaqès, le premier myrte." This mysterious translation is explained by the fact that apparently Berthelot's translator did not know the meaning of the word *Usṭuqus* and mis-read *Ās* (myrtle) for *Uss* (base or foundation). *Usṭuqus* is, I believe, an Arabic transliteration of the Greek ἑστηκώς, which is used by Aristotle in the sense of "firm" or "solid," and was extended in meaning to include the basis of anything, and thus, for example, the "four elements" as the basis of all things.

The "Kitāb Usṭuqus al-Uss al-Awwal" (al-Awwal = *the first*) is followed by a second (al-Thānī) and a third (al-Thālith), and although no MSS. of these works are known in Europe, there are, I believe, some in India, where in 1891 a lithographed edition was published. The copy I have used was kindly lent me by Mr. A. G. Ellis of the British Museum. Now, in the second book of the *Usṭuqus* (p. 41 of the lithographed edition) occurs the passage: "Balīnās mentions the engraving on the table in the hand of Hermes, which says:

'Truth! Certainty! That in which there is no doubt!

'That which is above is from that which is below, and that which is below is from that which is above, working the miracles of one [thing].

'As all things were from One.

'Its father is the Sun and its mother the Moon.

'The Earth carried it in her belly, and the Wind nourished it in her belly, as Earth which shall become Fire.

'Feed the Earth from that which is subtle, with the greatest power.

'It ascends from the earth to the heaven and becomes ruler over that which is above and that which is below.'

"And I have already explained the meaning of the whole of this in two of these books of mine."

Although the Arabic text of the Table is obviously corrupt, and the translation of it here given therefore uncertain in one or two minor points, there can be no doubt that a version in Greek was known to Jābir, since the correspondence of the above with the Latin text—the appropriate portions of which are appended—is very close:

"1. Verum sine mendacio certum et verissimum.

"2. Quod est inferius est sicut quod est superius, et quod est superius est sicut quod est inferius, ad perpetranda miracula rei unius.

"3. Et sicut omnes res fuerunt ab uno meditatione unius, sic omnes res natae fuerunt ab hac una re adaptione.

"4. Pater ejus est Sol, mater ejus Luna, portavit illud ventus in ventre suo, nutrix ejus terra est.

* * * * * *

"7. Separabis terram ab igne, subtile a spisso, suaviter magno cum ingenio.

"8. Ascendit a terra in coelum, iterumque descendit in terram, et recipit vim superiorum et inferiorum."

The Balīnās mentioned by Jābir is Apollonius of Tyana, who was born a few years before the Christian era, and acquired a great reputation in the East as a wonder-worker and as a master of the talismanic art.

It seems, therefore, that we must antedate the "Tabula smaragdina" by four hundred years at least, and probably by twelve hundred; its existence in a Greek form is rendered in the highest degree probable, and it must be acknowledged that in the Tabula we have one of the oldest alchemical fragments known.

University and Educational Intelligence.

Cambridge.—The vice-chancellor, Dr. E. C. Pearce, in the course of his address on the opening of the new academic year on October 1, said that the University Grants Committee had informed him that from the academic year now opening the Government proposes to make an additional annual grant of 30,000*l.* to meet the needs of the University for superannuation, stipends, maintenance of the Library, extension of extra-mural work, and the women's colleges; in addition a non-recurrent grant, not exceeding 35,000*l.*, will be payable in respect of superannuation arrears.

Glasgow.—Dr. J. R. Currie, professor of preventive medicine in Queen's University, Kingston, Ontario, has been elected to the newly established Henry Mechan chair of public health. Dr. Currie during the War was specialist sanitary officer at Toronto and Dunkirk, and was Medical Officer of the Scottish Board of Health 1919–1922. His work on the "Mustering of the Medical Service in Scotland," published last year, gives a stirring account of the efforts made in Scotland to keep up the supply of medical officers for the Army and Navy, and to organise the remainder for civil needs. Dr. Currie was secretary of the Emergency Medical Committee.

St. Andrews.—Dr. Adam Patrick has been chosen by the University Court to succeed Prof. Stalker in the chair of medicine, and the directors of the Royal Infirmary, Dundee, have appointed him one of their physicians. Dr. Patrick is a graduate in arts with honours in classics and M.D. with honours of the

University of Glasgow. He has been assistant successively to Prof. Samson Gemmell and Prof. T. K. Munro, of the chair of medicine at Glasgow. During the War he was working for more than three years as a specialist in bacteriology in Malta and held other appointments in the Army Medical Service.

On the nomination of the Council of the St. Andrews Institute for Clinical Research, the Court has appointed Mr. Norman Maclennan to the lectureship in bacteriology vacant through the resignation of Lt.-Col. W. F. Harvey.

DR. ROHMANN, professor of physics at the Munster University, formerly at Strasbourg, has been appointed to the newly-founded chair of mathematics and physics in the Forstlichen College, Hann.

THE Bocconi Commercial University, Milan, has resumed this year the publication, suspended since 1915, of its Annuario. Its student enrolment shows a steady increase from 65 in 1915–16 to 352 in 1919–20, followed by a decrease to 293 in 1921–22. The teaching staff comprises 31 professors and lecturers. Annexed to the University are an institute of political economy and a laboratory of technical and commercial research.

THE Faculty of Medical Sciences of the University of London, University College, announces for 1923–24 that each of the departments for the preliminary and intermediate medical sciences is equipped not only for the preliminary and intermediate courses for medical degrees but also for more advanced work. Organised courses of advanced study in experimental physiology and biochemistry are provided, and there are post-graduation courses in hygiene and public health leading to the various diplomas and qualifications in public health. A special post-graduate prospectus is being issued.

STATE policies in regard to the financing of public instruction are described and criticised by Prof. Fletcher H. Swift of the University of Minnesota in Bulletin 1922, No. 6 of the United States Bureau of Education. The growth of expenditure on the public schools since 1871 in the United States has been 900 per cent., varying from 750 in the North Atlantic and North Central States to 1400 in South Atlantic and South Central and 4000 per cent. in the Western States. The professor opines that these expenditures will continue to increase, and he recommends that the major portion of the burden be shifted from the local communities to the State. He would have the State provide the cost of teachers' salaries, supervision, general administration, and the supply of such materials as text-books and laboratory apparatus, leaving to the local communities the provision, furnishing, repairing, operating, and maintaining of school buildings, together with responsibility for fuel, water, light, power, insurance, playgrounds, and play apparatus. He estimates that the State would, under such a distribution, have to bear from 75 to 80 per cent. of the total costs. To "worshippers at the shrine of the ancient fetish of local support and local control" he says this system has led to "multitudes of children being denied educational opportunity and the herding of thousands in dismal hovels under the tutelage of wretchedly underpaid teachers, while hundreds of communities are able to provide luxurious educational facilities." One would like to know whether Prof. Swift has seen Mr. Bernard Holland's article in the *Edinburgh Review* for January, in which some of the disadvantages of centralised control of education are set forth.

Societies and Academies.

PARIS.

Academy of Sciences, September 10.—M. Emile Roux in the chair.—M. **Hadamard**: Vortices and surfaces of slipping in fluids.—Louis **de Broglie**: Waves and quanta.—MM. **Mengaud** and **Mourié**: The meteorite of Saint-Sauveur (Haute Garonne): the circumstances of its fall.

CAPE TOWN.

Royal Society of South Africa, July 18.—Dr. A. Ogg, president, in the chair.—E. **Newbery**: On a proposed modification of the cathode ray oscillograph. The modification would fit the instrument better for the study of over-voltages.—J. S. **Thomas** and R. W. **Riding**: Note on the polysulphides of ammonium, with some considerations regarding the constitution of the polysulphides of the alkali metals. The action of sulphur on solutions of ammonium hydrosulphide in dry alcohol resulted in the formation of ammonium pentasulphide only. When sodium is the metal used, the tetrasulphide is formed; with potassium the pentasulphide. Ammonium pentasulphide in alcoholic solutions is capable of dissolving still more sulphur, and there is evidence of the existence of higher polysulphides; a heptasulphide has been isolated. Pyridine and nitrobenzene react with ammonium pentasulphide, giving highly coloured solutions. There is probably in the polysulphide molecule, two sulphur atoms in a different state of combination from the remainder, and the disulphides may be regarded as being derived from a form of hydrogen disulphide represented by the formula H.S.S.H. Higher polysulphides are then formed by the addition of sulphur to the disulphides, compounds of the type $\mathrm{R.}\underset{\substack{\parallel \\ \mathrm{S}}}{\mathrm{S}}\mathrm{.S.R}$, $\mathrm{R.}\underset{\substack{\parallel \\ \mathrm{S}}}{\mathrm{S}}\mathrm{.}\underset{\substack{\parallel \\ \mathrm{S}}}{\mathrm{S}}\mathrm{.R.}$, etc., being thus obtained. This view is confirmed by the decomposition of ammonium pentasulphide into the disulphide and free sulphur. The reaction takes place at a low temperature and is quantitative in character.—M. **Rindl**: The active principle of *Homaria pallida* (Yellow Tulp). The active principle has digitalis-like physiological effects.

CALCUTTA.

Asiatic Society of Bengal, August 1.—F. C. **Fraser**: Zoological results of the Percy Sladen Trust Expedition to Yunnan, under Professor J. W. Gregory, in 1922.—Dragonflies. The collection consists of nearly 200 specimens, the majority of which belong to the sub-family Libellulinæ. The species are mostly Oriental, but a few Palæarctic forms occur from high altitudes. Twenty-three species are represented, of which seven are described as new.—B. **Prashad**: Observations on the respiration of the Ampullariidæ. After a short survey of the previous literature on the subject of the respiration of the apple snails, an account of the respiration in the common Indian *P. globosa* is given. The peculiarities noted in the case of the hill-stream form *Turbinicola saxea* are also described, and the probable causes of these peculiarities with reference to the hill-stream habitat are discussed.

Official Publications Received.

Proceedings of the Royal Society of Edinburgh, Session 1922–23. Vol. 43, Part 2, No. 8: The Theory of Alternants from 1896 to 1917. By Sir Thomas Muir. Pp. 127-148. 2*s*. Vol. 43, Part 2, No. 9: The Mechanism behind Relativity. By Dr. W. Peddie. Pp. 149-153. 9*d*. Vol. 43, Part 2, No. 11: Further Tests upon Dewar Flasks intended to hold Liquid Air. By Henry Briggs and John Mallinson. Pp. 160-169. 1*s*. Vol. 43, Part 2, No. 12: The Interior and Exterior Space-Time Forms of the Poincaré Electron in Weyl's Geometry. By John Marshall. Pp. 170-179. 1*s*.

Vol. 43, Part 2, No. 13: A Static Model of the Hydrogen Molecule. By Prof. H. Stanley Allen. Pp. 180-196. 1s. 6d. Vol. 43, Part 2, No. 14: The Slow Oxidation of Phosphorus. By Dr. Elizabeth Gilchrist. Pp. 197-215. 1s. 9d. Vol. 43, Part 2, No. 15: Notes on a New Method of Investigating Colour Blindness. By Dr. R. A. Houstoun and Dr. W. H. Manson. Pp. 216-218. 9d. (Edinburgh: R. Grant and Son; London: Williams and Norgate.)

Smithsonian Miscellaneous Collections. Vol. 74, No. 6: Designs on Prehistoric Pottery from the Mimbres Valley, New Mexico. By J. Walter Fewkes. (Publication 2713.) Pp. 47. Vol. 76, No. 1: Some Practical Aspects of Fuel Economy. By Carl W. Mitman. (Publication 2715.) Pp. 19. Vol. 76, No. 7: Description of an Apparently New Toothed Cetacean from South Carolina. By Remington Kellogg. Pp. ii+7+2 plates. (Washington: Government Printing Office.)

Commonwealth of Australia: Institute of Science and Industry. Bulletin No. 24: The Production of Liquid Fuels from Oil Shale and Coal in Australia. By R. E. Thwaites. Pp. 62. (Melbourne.)

Memoirs of the Indian Meteorological Department. Vol. 23, Part 6: On Indian Monsoon Rainfall in relation to South American Weather, 1875-1914. By R. C. Mossman. Pp. 157-242. (Calcutta: Government Printing Office.) 2 rupees.

Nova Acta Regiæ Societatis Scientiarum Upsaliensis. Ser. 4, Vol. 6, No. 2: Innere Bewegungen in den Zwischenschichten des Meeres und der Atmosphäre. Von O. Pettersson. Pp. 48. (Uppsala: E. Berlings Boktryckeri A.-B.)

Publikationer fra det Danske Meteorologiske Institut. Meddelelser Nr. 5: Meteorological Problems. By V. H. Ryd. 1: Travelling Cyclones. Pp. iv+124. (Kjøbenhavn: G. E. C. Gad). 5 kr.

Ministry of Public Works, Egypt. Physical Department Paper No. 10: A Barometric Depression of the Khamsin Type, by L. J. Sutton; Effect of Wind Direction on Temperature and Humidity at Jerusalem, by S. Krichewsky. Pp. 15+12 plates. (Cairo: Government Publications Office.) P.T. 5.

Scientific Survey of Porto Rico and the Virgin Islands. Vol. 2, Part 1: The Geology of the Lares District, Porto Rico. By Bela Hubbard. Pp. 115. (New York: Academy of Sciences.)

New Zealand Department of Mines: Geological Survey Branch. Bulletin No. 25: The Geology and Mineral Resources of the Collingwood Subdivision, Karamea Division. By M. Ongley and E. O. Macpherson. Pp. vi+52+4 plates+4 maps. (Wellington: W. A. G. Skinner.) 6s.

Proceedings of the Royal Society of Victoria. Vol. 35, Part 2: Containing Papers read before the Society during the months of August to December 1922. Pp. 115-217. (Melbourne.)

Proceedings of the South London Entomological and Natural History Society, 1922-23. Pp. xviii+152+8 plates. (London: Hibernia Chambers, S.E.) 10s. 6d.

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 2, No. 18: The Igneous Geology of the Dalmeny District. By Dr. Frederick Walker. Pp. 361-375+1 plate. 2s. ?d. Vol. 53, Part 2, No. 19: The Physiography of the Moray Firth Coast. By Alan G. Ogilvie. Pp. 377-404. 3s. 6d. (Edinburgh: R. Grant and Son; London: Williams and Norgate.)

Memoirs of the Department of Agriculture in India: Entomological Series. Vol. 7, No. 12: Further Notes on *Pempheres affinis*, Fst. (the Cotton Stem Weevil). By E. Ballard. Pp. 243-255+4 plates. 1 rupee; 1s. 4d. Vol. 8, Nos. 1, 2, 3: *Hydrophilidæ* of India (Col.): a List of the Species in the Collection of the Agricultural Research Institute at Pusa (Bihar), by A. d Orchymont; an Annotated List of Ichneumonidæ in the Pusa Collection, by G. R. Dutt; a Second Note on Odonata in the Pusa Collection, by Major F. C. Fraser. Pp. 34. 1 rupee; 1s. 6d. Vol. 8, No. 4: Notes on Indian Muscidæ. 1: Calliphorinæ Testaceæ; 2: Rhiniinæ, By Ronald Senior-White. Pp. 35-52+3 plates. 12 annas; 1s. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.)

Agricultural Research Institute, Pusa. Bulletin No. 44: Observations on the Morphology and Life-Cycle of *Filaria recondita*, Grassi. By Prof. M. Anant Narayan Rao. Pp. 7+2 plates. 6 annas. Bulletin No. 145; Some Observations on Barren Soils of Lower Bari Doab Colony in the Punjab. By S. M. Nasir. Pp. 11. 3 annas. (Calcutta: Government Printing Office).

Indian Forest Records. Vol. 9, Part 7: Notes on the Possibilities of Camphor Cultivation from *Cinnamomum Camphora* in Northern India. By Stanley H. Howard, Wheatley A. Robertson, and John L. Simonsen. Pp. 34+6 plates. 1.4 rupees. Vol. 9, Part 8: The Constituents of some Indian Essential Oils. By John L. Simonsen. Parts 9-10. Pp. 8. 4.6 annas. (Calcutta: Government Printing Office.)

Field Museum of Natural History: Botanical Series. Vol. 5: Flora of Santa Catalina Island, California. By Charles F. Millspaugh and Lawrence W. Nuttall. (Publication 212.) Pp. 413+14 plates. (Chicago.)

Bernice P. Bishop Museum. Bulletin 2: Early References to Hawaiian Entomology. By J. F. Illingworth. Pp. 63. Bulletin 3: Hawaiian Legends. By William Hyde Rice. Pp. 137. Bulletin 5: Crustacea from Palmyra and Fanning Islands. By Charles H. Edmondson: with Descriptions of New Species of Crabs from Palmyra Island, by Mary J. Rathbun. Pp. 43+2 plates. (Honolulu.)

Bulletin of the American Museum of Natural History. Vol. 49, Art. 1: Contributions to the Herpetology of the Belgian Congo, based on the Collection of the American Museum Congo Expedition, 1909-1915. By Karl P. Schmidt. Part 2: Snakes. With Field Notes by Herbert Lang and James P. Chapin. Pp. 146+22 plates. (New York.)

Reprint and Circular Series of the National Research Council. No. 45: List of Manuscript Bibliographies in the Biological Sciences. By Clarence J. West and Callie Hull. Pp. 51. (Washington: National Academy of Sciences.) 50 cents.

The University of Leeds: Department of Leather Industries. Report of the Advisory Committee on the Work of the Department during Sessions 1921-23. Pp. 10. (Leeds.)

Report on the Administration of the Meteorological Department of the Government of India in 1922-23. Pp. 16. (Simla: Government Press.) 4 annas.

Memoirs of the Department of Agriculture in India: Chemical Series. Vol. 7, No. 2: Studies of an Acid Soil in Assam, II. By A. A. Meggitt. Pp. 31-53. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 12 annas; 1s.

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums for the Year ending December 31, 1922. By William Henry Fox. Pp. 59+3 plates. (Brooklyn.)

Transactions of the Leicester Literary and Philosophical Society, together with the Report of the Council for 1922-23 and Annual Reports of the Sections. Vol. 24, 1923. Pp. 58. (Leicester.)

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. Boletim Meteorologico. Anno de 1919. Pp. 154. (Rio de Janeiro.)

Records of the South Australian Museum. Vol. 2, No. 3. Pp. 321-4[illegible]+plates 5-22. (Adelaide.) 7s. 6d.

Journal and Proceedings of the Royal Society of Western Australia. Vol. 9, Part 1, 1922-23. Pp. 70. (Perth.) 5s.

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 3: History of the Manual Training School of Washington University (St. Louis Manual Training School). By Charles Penney Coates. Pp. iii+86. (Washington: Government Printing Office.) 20 cents.

Commonwealth of Australia: Institute of Science and Industry. Pamphlet No. 3: The Co-operative Development of Australia's Natural Resources. By Gerald Lightfoot. Pp. 20. (Melbourne.)

Lyme Regis Museum of Geology and Archæology. Guide and Report, 1923. Pp. 16+2 plates. (Lyme Regis.)

Edinburgh and East of Scotland College of Agriculture. Calendar for 1923-24. Pp. 90. (Edinburgh.)

Proceedings of the Cambridge Philosophical Society. Biological Sciences, Vol. 1, No. 1. Pp. 62+5 plates. (Cambridge.) 12s. 6d. net.

Proceedings of the Royal Irish Academy. Vol. 36, Section A, No. [illegible]: Experiments on Large Ions in Air. By J. J. Nolan and J. Enright. Pp. 93-114. Vol. 36, Section A, No. 7: Solutions of Systems of Ordinary Linear Differential Equations by Contour Integrals. By W. M'F. Orr. Pp. 115-130. Vol. 36, Section B, No. 5: The Constitution of Catechin. By James J. Drumm. Part 1. Pp. 41-49. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate.) 1s. each.

Proceedings and Transactions of the Croydon Natural History and Scientific Society. Vol. 9, Part 3, February 1921 to January 1923. (Croydon.) 5s. net.

The National Council for the Unmarried Mother and her Child. Fifth Annual Report, 1923. Pp. 16. (London: 117 Piccadilly.)

Diary of Societies.

TUESDAY, OCTOBER 9.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—E. H. Cunningham Craig: Recent Research bearing upon the Origin of Petroleum.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—W. J. N. Vanstone: The Pyramids of Egypt. (Ladies' Night.)

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—O. Brockbank: Petra, the Rosé Red City.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. E. W. Bowell: The Radulæ and how to mount them.

WEDNESDAY, OCTOBER 10.

PREHISTORIC SOCIETY OF EAST ANGLIA (at Geological Society), at 2.15.—J. G. Marsden: Note on Flint Implements of Le Moustier Type from Camborne and Southampton.—Henry Bury: Some Aspects of the Hampshire Plateau Gravels (Presidental Address).—M. C. Burkitt: A Newly Discovered Transition Culture in North Spain. — A. L. Armstrong: Preliminary Report on the Discovery of a hitherto Unknown Phase of Early Mining at Grimes' Graves.—Major A. G. Wade: A Series of Ancient Flint Mines at Stoke Down, Sussex.

INSTITUTION OF WELDING ENGINEERS (at Holborn Restaurant), at 8.—Electric Welding; Gas Welding.

THURSDAY, OCTOBER 11.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 8.—Dr. D. Hanson: Chairman's Address.

FRIDAY, OCTOBER 12.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. T. Holland: The Snow and Ice Scenery of Switzerland.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. Y. Lewis: The Never Stop Railway.

PUBLIC LECTURES.

MONDAY, OCTOBER 8.

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: The Philosophy of Bernard Bosanquet.—Prof. D. Jones: The Application of Phonetics to the Languages of the British Empire.

KING'S COLLEGE FOR WOMEN (Household and Social Science Department), at 5.—Prof. V. H. Mottram: Newer Aspects of Nutrition. (Succeeding Lectures on October 15, 22, 29; November 5, 12, 19, and 26.)

TUESDAY, OCTOBER 9.

KING'S COLLEGE, at 5.30. — Prof. H. Wildon Carr: The Hegelian Philosophy and the Economics of Karl Marx. (Succeeding Lectures on October 16, 23, and 30.)

UNIVERSITY COLLEGE, at 5.30.—Prof. C. Spearman: Psychology as Transfigured Behaviourism.

GRESHAM COLLEGE (Basinghall Street), at 6.—A. R. Hinks: Astronomy. (Succeeding Lectures on October 10, 11, and 12.)

WEDNESDAY, OCTOBER 10.

KING'S COLLEGE, LONDON, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System. (Succeeding Lectures on October 17, 24, 31; November 7, 14, 21, and 28.)

UNIVERSITY COLLEGE, at 5.—Morris Ginsberg: The Sociological Work of the late Dr. W. H. R. Rivers;—at 7.—A. H. Barker: The Heating Equipment of a Small House.

SATURDAY, OCTOBER 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Capt. W. H. Date: Wireless Telephony—a Popular Exposition.

SATURDAY, OCTOBER 13, 1923.

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A Representative Body for Science.

FROM time to time proposals have been made for the establishment of a body representative of British scientific opinion—professional or otherwise; and various opinions have been expressed as to the constitution and functions of a body of this kind. It seems desirable, therefore, to consider some of the questions raised by these proposals.

First it may be asked whether such a body does not exist already. A fully representative body is one which can recommend a course of action in the perfect assurance that its recommendation will be accepted by all but an insignificant minority of its constituents. There are bodies representative in this sense of some groups of scientific workers; there are others which, in the opinion of their members, should be, or some day may become, fully representative. But there does not seem to be any body which actually possesses at the present time the necessary authority over all scientific workers.

The second question is whether there is such a thing as scientific opinion, of which any body can be representative. The opinion relevant to our discussion is not that concerning technically scientific matters. Such opinion is not formed in council, and needs no enforcement, even among the laity. The only matters on which a representative scientific body could usefully express an opinion are those on which the laity judge for themselves, and are not always prepared to accept the verdict of scientific workers. For our purpose there is no scientific opinion unless there are questions on which scientific workers, while agreeing substantially among themselves, are apt to differ from important sections of the rest of the community. There probably are such questions; for example, there is the recognition, economic, political, and social, to be given to scientific work. Other matters need not be mentioned; but, since our judgment of the desirability or possibility of a representative body is likely to be greatly affected by our view of the nature of the problems with which it will have to deal, every one who discusses the matter should start by suggesting to himself concrete examples of such problems.

Supposing, then, that it is decided that there is a group of problems on which a definite scientific opinion exists, we may proceed to inquire whether it is likely that any actual representative body would succeed in expressing it. If there is any doubt on this matter, it will probably arise from a fear that any body of the kind proposed would be sure to lose touch with the average scientific worker and fall under the domination of some unrepresentative clique. The danger must be recognised, for scientific workers are often not highly

endowed with the "political sense." Methods of avoiding it will be considered later; but here it may be pointed out that an undue insistence on the danger may defeat its purpose. It is fatal to assume at the outset that the body is going to fall into the hands of a clique; many promising organisations (not necessarily in the scientific world) have failed to express the general will merely because a large section of the community, seeing among its original promoters some persons with whom they disagree, have overlooked the presence of others with whom they do agree and have refused to join it. Further, it must be remembered that, if there is not perfect unanimity, the minority is sure to accuse the majority of being dominated by a clique; it always does. Every political party, for example, when it is really in a minority, always maintains that the nation is being led astray by some small band of evilly disposed persons.

Next, if there is a scientific opinion which can be expressed by a representative body, could it be enforced? Here any discussion would probably turn on the analogy of bodies representative of other professions, such as lawyers, teachers, or doctors. The analogy suggests that the outlook is promising, but the differences as well as the resemblances should be noted. Men of science form a much less homogeneous body than any of these three professions; moreover, the laity is, or was until quite recently, much less firmly convinced of the need for the profession at all. However, this is not the objection usually raised on this score; it is sometimes suggested that a representative scientific body, though it might exercise great influence, could attain its ends only by means of some coercion on its own members or the outside public, which is intrinsically undesirable. To those who do not believe that all interference with the action of others is illegitimate it may be suggested that "coercion" is a relative term. Most people use the term only when they object to the ends to which the proposed "coercion" is directed; they seldom shrink from any form of pressure which is unavoidable if ends are to be attained in the justice of which they believe firmly. Objection on this score is usually closely associated with the fear of a dominant and hostile clique.

These simple considerations suggest others concerning the constitution of a representative body. To-day all will probably agree that its constitution must be "democratic," that its constituents must include all who have any right to be termed scientific workers (and nobody else), and that each constituent must have equal voting power in determining its policy. But that is not enough; the constituents must be real and active, and must take a constant interest in the body supposed to represent them. This result will probably not be achieved if all representation is indirect, and the selection of the council (for some kind of council is clearly necessary) lies in the hands of subsidiary bodies appointed by direct election; such indirect election will be all the less satisfactory, if those subsidiary bodies are selected primarily for some other purpose. This point is important, because one method by which a representative body might be established would be by some kind of federation of existing organisations, such as the professional institutes. While it will probably be necessary, as well as desirable, that the institutes should be given a constitutional relation to any general representative council, we doubt whether a council based solely on such bodies would remain sufficiently closely in contact with all shades of scientific opinion. A considerable proportion of the "franchise" must surely be direct; and even that part which is indirect should take into account as many and diverse classifications of the scientific community. Even in the initial stages, which lead up to the establishment of the representative body, direct expression of opinion should be encouraged. We think that no steps should be taken until the proposals have been fully discussed either at meetings or in the columns of scientific journals.

But no franchise, however perfectly designed, can secure the continual interest which is the sole guarantee of true representation. The representative body must have some work to do which will affect every constituent and make it impossible for any one to remain indifferent. This work need not necessarily concern matters on which there is likely to be general agreement, and on which it is proposed that the body shall make a pronouncement of scientific opinion to the outside world; indeed, any pronouncement which the body may make with substantial unanimity will have much greater force if it is known that on other matters of internal moment there is no sign of unanimity. The body must not seek to secure an undisturbed atmosphere of philosophic calm; it must handle controversial issues, because they alone are vitally interesting.

Here is the gravest problem; for if any controversial issue is recognised from the start as within the scope of the body, those who think they will be in a minority on that issue will try to hinder its establishment, and will undoubtedly succeed. We would, therefore, put forward a concrete suggestion. It is that, at the outset, the body should direct its attention to one problem only, namely, to the establishment of a register of qualified scientific workers. The problem will have to be solved if the body is to be called into existence; it raises difficult questions on which almost every one has some opinion; but the controversies that are likely to arise in its discussion will not necessarily be

fatal. They are not likely to be bitterly personal; for at the start all questions will concern classes and not individuals; it is sure to be recognised that individuals already existing are given the benefit of every possible doubt. Again, minorities are likely to resent exclusion rather than inclusion; the hostility of a minority whom it is proposed to exclude is clearly not so important as that of one which, by its secession, can ruin the scheme. Further, a registering body would probably have little difficulty in securing immediately some official position and recognition. These reasons seem to point clearly to registration as the first task of the representative body; but, since registration in science is not a matter of primary importance, we would make it clear that we do not think it worth while to establish a registering body unless it is understood that, when this part of its work is concluded, it is to develop wider activities.

Synthetic Colouring Matters.

Synthetic Colouring Matters: Dye-stuffs derived from Pyridine, Quinoline, Acridine and Xanthene. By Prof. J. T. Hewitt. (Monographs on Industrial Chemistry.) Pp. xi+405. (London: Longmans, Green and Co., 1922.) 14*s*. net.

IT is probable that when the monographs on colouring matters which are promised in the introductory note to Sir Edward Thorpe's series on industrial chemistry have been published, they will represent as complete a compilation of the essential facts as exist in any language. Moreover, they will probably form a convenient source from which those who wish to obtain full information on this important branch of organic chemistry can readily do so without having to spend time and energy in consulting such cumbersome literature as that of the *Fortschritte*. The first volume to appear, that on the "Natural Colouring Matters," by Perkin and Everest, is already known and appreciated by chemists, and we have now to look forward to the publication of no less than six volumes on synthetic colouring matters by authors who should know what they are writing about. The first of these volumes to appear has the title given at the head of this review, and sets a standard which augurs well for the success of the series.

Probably few books are more difficult to write (or to read) than those which deal with a highly specialised and commercialised branch of science, such as that which includes the synthetic colours. It would not be so bad if scientific literature alone had to be summarised, because in that case the author's task of discriminating between fact and fable would be reduced to a minimum. With the synthetic colours, however, much of the grain is hidden under the mass of chaff which constitutes the patent literature, and the difficulties of winnowing are great. It is difficult to understand why so much money and energy are devoted to the collation of chemical patent literature when, as most people know, much of it is untrue and a great deal of the remainder misleading. Chemical patent literature is, and always has been, and probably always will be, written by lawyers for lawyers; and it will probably always be the case, in spite of restrictive legislation, that the manufacturing firms concerned will often be inclined to place no small value on any publication which tends to mislead their competitors, and where some is false all must be suspect. Still, in many cases, the sole source of information respecting the synthetic colours lies in the patent literature and, in consequence, an author has to exercise a wise discretion in sifting and arranging all the material which comes to his hand. It follows, therefore, that the possession of a wide knowledge, not only of his subject but also of the technique of his subject, is essential if the result is to be in any way comparable with the energy expended, and, probably, no one is more fitted than the author of this work—an old and honoured worker in many of the fields he describes—to undertake the task he has accomplished so admirably.

Prof. Hewitt's work is a readable book, although it contains a mass of complex information, and its readability is due to the manner in which the author has summarised and, in some cases, criticised the material he has collected. His criticism is, however, neither carping nor hostile, but is always expressed in a detached and almost humorous manner, which is so characteristic that it cannot fail to raise a smile upon the lips of those to whom he is personally known.

Although originally intended to be a book on the acridine and xanthene colouring matters, it was ultimately found necessary to include those derived from pyridine and quinoline, and the first four chapters are devoted to a description of these bases and the colours obtained from them. It is perhaps fortunate that the change was made, because it enabled the author to include a description of the cyanine group, many members of which are important photographic sensitising dye-stuffs. The next five chapters are devoted to the acridine derivatives and contain an exhaustive account of these colouring matters. Chapter x. deals with the pyrone ring, and introduces the history and description of the oxonium salts. The subject-matter of this chapter naturally leads to a description of the colouring principles of flowers, but one finds, with some regret, that there the author breaks off and refers the reader to the previous monograph by Perkin and Everest. Surely a little overlapping in this series

of monographs is not only inevitable but desirable. The remaining chapters give interesting accounts of the pyronines and rosamines; the constitution of fluorescein and analogous compounds; the constitution of the rhodamines and their manufacture; and the chemistry of the rhodols and anisolines. Of special interest, from the general point of view, is the discussion of the constitution of phenolphthalein and fluorescein, which is given in a manner which will appeal to those students who have to approach these difficult problems for the first time.

The book is well printed and the very complex formulæ are particularly clear and easy to follow. It is stated to have been printed in Saxony, and this probably accounts for some of the quaint spelling which has escaped the vigilance of the proof-reader. "Recomends" on p. 11, "wather-bath" on p. 29, the inverted commas on p. 66, "occour" on p. 289, "preapare" on p. 269, "doubtfoul" on p. 38, "ac" on p. 56, "annother" on p. 58, "occurence" on p. 64, "alo" on p. 91, and "accridine" on p. 120 meet the eye and are perhaps inevitable in the circumstances. Moreover, it is difficult to know what the "dashes" after the names of Williams and Hofmann on p. 55 really mean. But these are minor faults, and both the author and the editor are to be congratulated on the production of a volume which will long remain the standard treatise on the subject with which it deals.

J. F. THORPE.

The Eye and Vision.

The Present Status of Visual Science. By Dr. Leonard Thompson Troland. Pp. 120. (Bulletin of the National Research Council. Vol. 5, Part 2, No. 27.) (Washington: National Academy of Sciences, 1922.) 1.50 dollars.

THE eye can be regarded as holding a unique position among the organs of special sensation, because of all methods of observation, those carried out by vision, either unaided or through the medium of suitable accessory apparatus (*e.g.* the photographic plate), are the most accurate, rapid, and susceptible of the widest application. Moreover, the problems which the eye presents for solution are of interest, not only to the physiologist and anatomist, but also to the oculist, physicist, psychologist, and the illuminating engineer, and much has therefore been written by them in their own respective spheres. So plentiful, in fact, has the literature of vision become, that a complete mastery of the subject is possible to few. Dr. Troland has therefore achieved a result of great value in the publication of the book before us.

Early in the book, and again in the concluding pages, Dr. Troland utters a word of warning; there are, he points out, too many papers published on vision. Many authors, he says, "show a lack of acquaintance with the problems and results with which the others are concerned" (p. 10), and "appear also to have a profound contempt for existing literature, even when it is in their own language" (p. 110). In many papers there is "an absence of that complete specification of all circumstances surrounding experimentation which is needed to render the results of any permanent value" (p. 110).

The reader of Dr. Troland's book will find that the pages which follow the introduction are written with three objects in view: to indicate as clearly as possible the lines of cleavage between the physiological, psychological, and physical aspects of vision; to summarise the well-established facts concerning the various mechanisms associated together in the eye; and to indicate the points where our knowledge is defective or altogether absent. Owing to the necessity for brevity it is not possible to go over all three parts of Dr. Troland's book in this review. The last one will alone be selected for detailed consideration, because it recalls some of the well-established facts of vision at the same time that it indicates the direction which future research should take.

Considering, in the first place, those eye structures which co-operate to form an image on a retina, Dr. Troland writes (p. 39): "The ophthalmoscope, the skiascope, and the corneal microscope (supplemented by Gullstrand's slit-lamp) provide us with instruments for examining the tissues of the living eye in a very satisfactory way." Elsewhere he adds (p. 40): "Helmholtz was able to work out satisfactorily the main dioptric or refractive function of the eye from data of optical anatomy, in combination with the established general principles of physical optics." The word "satisfactorily" in the above sentence unfortunately cannot pass unchallenged, because, although we know the positions of the principal points of the eye according to Gauss's theorem with considerable accuracy, and although we know that the eye suffers from certain aberrations, the data from which we can calculate the distribution of light intensity in the image formed on the retina are very deficient. Neither can we check our calculations by direct observations of the retinal image, because the structures found in the retina are insufficiently fine for the purpose, and we are unable to remove the retina and examine the image by other means without reducing the intra-ocular pressure, and thus allowing the distances between the optical surfaces to alter.

What is wanted is a method of quantitative estimation, applicable to the retinal image, no less accurate than that devised by Hartmann for studying the

aberrations of photographic objectives, which has been recently adapted to microscopic objectives also.

Reference may now be made to one other part of the dioptric mechanism, namely the "accommodation." Of this Dr. Troland writes (p. 40) that Helmholtz's theory "borders on the line between legitimate inference and mere hypothesis." In this connexion we may recall that many physiologists hold Tscherning's theory to be the correct one. In fairness to the memory of Helmholtz, it should, however, be stated that several recent workers have obtained results wholly in favour of his view.

Of the retina, and the nature of the processes by which light and colour are perceived, Dr. Troland writes (p. 43): "It is to be regretted that relatively little work upon the microscopic anatomy of the retina has been done in recent times, the epoch-making researches of Raman y Kajal having found no worthy successors." With this opinion every physiologist must regretfully agree; but will there be such unanimity over Dr. Troland's dismissal of Edridge-Green's theory in the following words?—"Views such as those of Edridge-Green, who regards the rods as non-photosensitive manufacturers of visual purple, which latter is operative only in stimulating the cones, may be dismissed at once without serious consideration." Now, however difficult it may be for some of us (who have been, as it were, brought up on the duplex theory of von Kries, which teaches that the rods function in night vision, and that while the hen has no rods and is therefore night blind, the bat has no cones and is therefore day blind) to accept Edridge-Green's hypothesis, we must feel that to dismiss it without consideration is to act too impulsively.

The criticisms which Edridge-Green advances against the older view are very weighty and worth serious thought. It is possible that, as so often in physiology, parts of both views are true and that there may be some half-way hypothesis acceptable to both parties; such, for example, as this: that while cones function principally by day for the appreciation of colour, and rods by night, yet cones do function to some extent at night, by a partial retention of the old functions of the rods from which they were presumably developed, while, on the other hand, rod vision is still to some extent operative in day vision, particularly in regions of the retina, on which are falling parts of the image corresponding to the shadows. It is only by dismissing nothing without consideration, and by research on the lines of Kuhne and of Hecht, that this important problem will be finally solved.

Much the same statement must be made concerning the appreciation of colour. New hypotheses, based on the quantum theory, are springing into being, and there are not sufficient data to enable a decision to be made between them and the older trichromatic theory of Young. Colour mixture equations would suggest that there are pigments present in the retina other than visual purple, but there is great need of direct proof of their existence and quantitative information concerning their distribution in the retina and their spectrophotometric properties. It is not the repetition, which Dr. Troland advocates, of older work that is wanted so much as entirely new lines of attack.

Many other important branches of visual science are dealt with by Dr. Troland in his book, but enough has been written here, perhaps, to show that the volume is a very real contribution to knowledge. No better incentive to future research could have been compiled; let us hope that the harvest will be a rich one.

H. Hartridge.

The Brackish-water Area of the Zuiderzee.

Flora en Fauna der Zuiderzee. Monografie van een Brakwatergebied onder redactie van Dr. H. C. Redeke en met medewerking van Tera van Benthem Jutting, H. Engel, H. C. Funke, Dr. A. C. J. van Goor, J. A. W. Groenewegen, Dr. B. Havinga, J. Hofker, Dr. R. Horst, Prof. Dr. P. N. van Kampen, Geertje de Lint, Dr. J. G. de Man, Prof. H. F. Nierstrasz, Dr. A. C. Oudemans, Prof. Dr. C. Ph. Sluiter, Dr. J. F. Steenhuis, Dr. J. J. Tesch, Dr. Adriana Vorstman, Nel de Vos, Prof. Dr. Max Weber en Dr. N. L. Wibaut-Isebree-Moens. Uitgegeven door de Nederlandsche Dierkundige Vereeniging ter Gelegenheid van Haar Vyftigjarig Bestaan. Pp. 460. (Helder: C. de Boer, Jun., 1922.) 10 guilders; for members of the Nederl. Dierk. Vereen., f. 2.50.

With the draining of the Zuiderzee one of the largest brackish-water basins of Europe, and a very peculiar one, will disappear. In the Baltic Sea, the largest of all, tidal movements are of very little importance: in the French and English river-estuaries, tides are the predominating factor, while in the Zuiderzee only a few small areas are struck by regular tidal currents, and the greater part of the southern basin is only shaken up from its lake-dreaminess by north-western gales. Therefore it was a very useful work of the Dutch Zoological Society (Nederlandsche Dierkundige Vereeniging), and specially of Dr. H. C. Redeke, the director of the Zoological Station in Den Helder, to bring together all that is known from the Zuiderzee in this monograph, issued on the occasion of the fiftieth anniversary of the Society.

In recent years a few small expeditions have been

made to increase our knowledge of the subject. As the middle part of the southern basin will not be drained, but remain open water, named Lake Flevo, we shall have a splendid opportunity of studying the changing of the brackish-water fauna into a fresh-water community. We do not know how long this will take, but, seeing the amount of water that is brought to the Zuiderzee by the river Yssel, it is almost certain that the days of the brackish Zuiderzee will be counted as soon as the dike between the provinces of Holland and Friesland from Wieringen to Piaam is ready, which will take another ten years. Nevertheless, we must be very glad that the research work has begun in such splendid style.

In the first chapter, the geology and hydrography are treated by Steenhuis and Redeke respectively. The geology is, of course, for the most part based on historical facts, as we know that two thousand years ago there was no Zuiderzee, but a Lake Flevo, as there will be again at the end of this century. The reason for this victory of the sea over the land must lie in the change in relative height of land and sea-level. The author does not give his opinion, however, about the cause of these changes. The hydrography, treated by Redeke, is of extreme importance, as we find here tables of temperature and salinity of the water in different parts of the basin during all seasons of the year. The lowest salinity (4 to 8 *per mille*) is found along the east coast, where the Yssel water flows, and causes a constant stream in a northerly direction.

The flora of the Zuiderzee is treated by Dr. van Goor, and the halophytes and submerged Phanerogams, the Algæ, and the phytoplankton are dealt with successively. Some fifty species of Algæ were collected, among them some that were previously unknown in the Dutch flora. The most important, however, is a new form of Fucus, baptised *F. intermedius*, nov. spec., which is intermediate between *F. vesiculosus* and *F. platycarpus*, and still not to be identified with the *Fucus ceranoides*, the brackish-water form of the French coast, which occurs also in the Schelde River. It should be of great interest to study the Fucus growth in Breydon Water, Hudson Bay, etc., to compare and try to find out more particulars of the distribution and life-history of this interesting group.

A comparison between the flora of the Baltic and Zuiderzee gives the interesting result that, while in the Baltic Cyanophyceæ and Peridiniales form by far the greatest part of the planktonic organisms, in the Zuiderzee the Diatoms play the most important rôle. The Copepod fauna of the Baltic and the Zuiderzee is much the same, but in the phytoplankton there is a difference even in the genera of the most important species.

The Protozoa are treated by Hofker, who gives a well-illustrated review of the specimens collected, which is of great value, as hitherto very little work has been done in Holland on these groups. Especially his account of the Foraminifera will prove a great aid for further investigation. It is highly probable that this shell-bearing group will furnish in later years just as good methods for analysing alluvial and diluvial deposits as diatoms already give. It is a great pity that the publication is merely systematic and morphological, for comparison with other faunas and a partition in salinity groups would have been of the greatest importance. We hope that this part of the work will follow, and point out that van Goor did it for the flora, Funke for the hydroids (twelve species), Geertje de Lint for Cladocera and copepods, etc.

Dr. de Man treats the free-living nematods, and describes among his forty-nine species no less than twelve that are new for science. For particulars I must refer to the publication itself. Twenty species of polychæt annelids were collected, and are treated by Dr. Horst; five species of Oligochætæ, described by Nel de Vos, while Dr. Wibaut-Isebree Moens shows that several Rotifera occur in fresh as well as in brackish water. Then we come to that important group, the Crustacea, important from the fisherman's, and therefore from the scientific point of view, as they have been very thoroughly studied recently. I have already mentioned the Cladocera and Copepoda, studied by Geertje de Lint. A new species of Schizopera is described.

Spongiæ, Cirripeda, Isopoda, Amphipoda, and Schizopoda are all treated, but show no special characters. Among the Decapoda, analysed by Dr. J. J. Tesch, *Leander longirostris*, called the Rhineprawn by British carcinologists, was found only once in the Zuiderzee. The life-history of the specific little Zuiderzee crab, *Heteropanope tridentata*, is very interesting; its only allies live in the tropical Pacific, and it has not been studied before. Illustrations of the larval states will prove very useful in recognising this interesting little creature.

A new Acaris is described by Oudemans; Havinga treats the marine Mollusca, of which several are of importance, as food for fishes and men. *Cardium edule* and *Mya arenaria* have typical brackish-water forms and measures. Among the fresh- and brackish-water Mollusca treated by Tera van Benthem Jutting is the famous *Corambe batava*, Kerbert, found for the first time in 1881; it appears to be not at all rare on the Zostera meadows of the Zuiderzee. Eggs and radula are described and represented. *Assemania grayana* appeared to be a sexual dimorph, the male being much smaller than the female, and being usually

found in summer riding on the weaker sex. Among the Bryozoa, treated by the same author, we find the beautiful *Membranipora membranacea* var. *erecta*, which is very common in brackish water in Holland.

Echinoderms and tunicates must be passed here for lack of space. Dr. Redeke's account of the fishes will be of special interest, not only to ichthyologists, but also to others, for here the different zones of salinity are separately described. Last comes Prof. Max Weber, who treats of ten species of cetaceans, of which specimens of all but one, the common Phocæna, have stranded on the banks of the Zuiderzee at different times.

A systematic index, more than eight pages in three columns, increases the utility of this important monograph of a brackish-water area.

W. G. N. VAN DER SLEEN.

Geology for Canadian Students.

Elementary Geology: with special reference to Canada. By Prof. A. P. Coleman and Prof. W. A. Parks. Pp. xx+363. (London and Toronto: J. M. Dent and Sons, Ltd., 1922.) 15*s*. net.

THE issue of treatises on general geology specially adapted to readers and observers in the units of our federal commonwealth is a sign of healthy autonomy in the domain of natural history. Colleges in the Dominions have long been troubled with the details of the English Oligocene, a poor thing at the best, or the Llandovery sequence on the Shropshire border. Aspirants in South Africa have been well served by Mr. A. L. Du Toit's "Physical Geography" and Prof. E. H. L. Schwarz's "South African Geology," since the latter includes a short general introduction to the science.

Profs. A. P. Coleman and W. A. Parks of Toronto now provide Canadian students with a sound elementary text-book based primarily on what may be seen in Canada or in the adjacent United States. The account of the Grenville and Keewatin series, the former consisting of altered shales (garnet-sillimanite gneisses) and crystalline limestones, and the latter of volcanic tuffs and lavas, is very valuable for European students who wish to realise the nature of the oldest known rocks revealed to us in the accessible crust. The eastern series, the Grenville, may prove to be somewhat older than the Keewatin of the west; but both are invaded by the great batholitic intrusions which have given rise, often by interaction with their surroundings, to what may still be styled the Laurentian gneiss. Prof. Coleman's work among the glacial beds of early Huronian age adds greatly to the interest of the pages on Pre-Cambrian rocks.

While European types of fossils are in places very justly figured, such as the Jurassic Trigonias and ammonites of England, we are introduced to the Cambrian trilobites of British Columbia, to Devonian fishes from Canada described by Traquair and Whiteaves, to the Permian reptile Dimetrodon of Texas, with its amazing dorsal spines, and to a Lower Cretaceous Stegosaurus from the province of Alberta. The Cainozoic era, styled also in this book the Tertiary period, is dealt with slightly; yet the thicknesses of its strata in many localities show that its duration was equal to that of Mesozoic times. The spelling "Cenozoic," adopted by the authors, though it follows Lyell's nomenclature of the systems, is etymologically misleading and should be synonymous with azoic. We greet on p. 353 an ancestor of the national maple leaf, culled from interglacial deposits in Toronto.

The book is finely printed and is handsomely illustrated throughout. Too much may have been attempted in one volume, and the definitions of divisions of the animal and vegetable kingdoms on pp. 155-160 are necessarily unsatisfying and incomplete. Some of these divisions are further treated in the chapters on stratigraphy; but where are the radiolaria, which have a significance as rock-formers? Five or six pages more would have made the description of mineral characters almost adequate. As it is, we have a not too accurate summary of the crystallographic systems (the principal axis, for example, in the tetragonal and hexagonal systems is said to be "long"), while we are led to suppose that quartz is hexagonal. Are the micas, again (p. 12), of different crystal systems? "Mont Pelée," an error sanctioned by Angelo Heilprin, appears under the fine photograph on p. 54. These are small details, and to point them out implies that we know that new editions will be required, and that the next one will still further enlighten us by the possession of an index.

GRENVILLE A. J. COLE.

Mental Athleticism.

Principles of Psychology: the Foundation Work of the Alétheian System of Philosophy. By Arthur Lynch. Pp. xxiii+408. (London: G. Bell and Sons, Ltd., 1923.) 21*s*. net.

MR. LYNCH some years ago published a book in two volumes entitled "Psychology: a New System." Whether, like a famous work of a famous predecessor—the Scots philosopher Hume—his book fell still-born from the press, or whether for other more personal reasons, he has decided to recast it. He now presents it in one volume and describes it as the foundation work of the Alétheian system of philosophy. (Why the first e in the word is given the French acute

accent we do not know.) The choice of the name seems to imply a slight on other systems, but probably nothing of the kind is intended, and it is only an expression of the author's boisterous confidence in his own powers.

The personal note is predominant throughout and makes it peculiarly difficult to discuss the doctrine, and impossible to controvert any of the positions. Of course, in psychology, the personal experience carries a peculiar weight. What Mr. Lynch explains to us is how he won his way to the possession of the clear mental grasp of the problem he now enjoys; how he overcame the stumbling-blocks he had to encounter in the perversity of authoritative teachers; how these obstructions actually served him to gain his vantage-point; and how we, if we will follow him, may become mental athletes also. Naturally his appeal is to the young. The curious thing to the older reader is that the solution offered as new is certainly not novel. We are to find the fundamental processes of mind in the same way in which the chemist and the physicist find the fundamental processes of matter. Having discovered them we shall find for the science of psychology, as they find for the sciences of chemistry and physics, that construction follows naturally. Very good, we may think, at any rate as a preliminary discipline,—but then Mr. Lynch does not set his followers to look for these fundamental processes, he puts in their hands the list of them. The processes are twelve in number, and the proof that they are fundamental and that the list is exhaustive is that Mr. Lynch has himself verified that they are so.

The reader will find an enormous number of references to other writers and an extensive survey of science in all its branches. Special importance is attached by the author to the section on memory, the whole of which is based on careful observations and experiments in connexion with his own personal experience.

Our Bookshelf.

John Penrose: a Romance of the Land's End. By J. C. Tregarthen. Pp. vi + 342. (London: J. Murray, 1923.) 7*s.* 6*d.* net.

It is not often that a book of fiction comes within the class of literature appropriately noticed in NATURE, but Mr. Tregarthen includes in his delightful romance of "John Penrose" so many interesting sketches of the wild life of the Land's End peninsula that we feel justified in recommending the book to all students of natural history.

Those who know West Cornwall must recall many an old man such as John Penrose was when the local parson inspired him to "put down" his recollections as the not uncommon farm boy who is keenly observant of the habits of the many pests, and a few wild friends, of the farmer working a small patch of land adjacent to an unreclaimed moorland. The wild animals come into the story as naturally as the human characters, and, with references to them, the author records many old local customs and beliefs that are in danger of being forgotten, as well as sayings and expressions of the old folk which are in danger of becoming obsolete through the influence of the modern school teacher, who, too often, gives his pupil the impression that old English provincialisms are vulgarisms inconsistent with modern education.

Not the least interesting among the conclusions to be gathered from the incidents described is the local attitude of highly respectable people to smuggling: to be entrapped by the preventive officers carried its measure of disgrace, but neither the otherwise rigidly honourable yeoman, nor even the parson, thought it wrong to conceal information about smuggling.

It is not easy to avoid anachronisms when writing autobiographically about a past period, and Mr. Tregarthen has not succeeded in avoiding every pitfall. In referring to the miners who had returned from the gold diggings of California the author recalls a familiar feature of West Cornish life in the 'sixties and 'seventies, but the incidents which he describes on pp. 2, 65, and 68 obviously refer to a period before 1848, the year in which the first Californian gold fever actually started.

T. H. H.

The Annual of the British School at Athens. No. 24. Sessions 1919–1920; 1920–1921. Pp. viii + 280 + 14 Plates. With Supplementary Paper No. 1: *The Unpublished Objects from the Palaikastro Excavations,* 1902–1906. Described by R. C. Bosanquet and R. M. Dawkins. Part 1. Pp. xii + 160 + 34 Plates. (London: Macmillan and Co., Ltd., 1923.) 63*s.* net.

THE article of most general interest in this excellent number is that by Mr. C. A. Boëthius on primitive house types as illustrated from Mycenæan and Nordic structures. The results of recent excavation on prehistoric Greek sites show that there is no evidence to support, still less to prove, the widespread assumption that the round hoop-roofed house is the original type from which all forms of human houses have been evolved. There is a considerable variety of primitive forms, and both rectangular and round huts and houses occur contemporaneously in ancient times and at the present day among primitive races. In Greece the neolithic material shows that well-developed round huts and equally advanced rectangular houses were contemporaneous. In Sweden we find round huts, possibly developed from a primitive tent or a screen against wind and rain. In the Bronze Age come oval houses developing into the rectangular form. "The evidence of primitive European dwellings shows, besides round tents or huts and pent roof structures, horseshoe screens with a fire in front of them, and rectangular screens with their various forms of development centring on the fire. Anywhere in Europe, climate and material can thus suggest a beginning which leads to a round hut, a horseshoe-shaped hut, or a rectangular hut with a central or eccentric hearth, and door at one end. A rectangular house with a central hearth can be just as elementary as a round or horseshoe-shaped neolithic hut, and of entirely independent origin."

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Micelle—A Question of Notation.

THERE is a class of colloids, recognised as a class for very many years, in which the substance is a salt of an ordinary ionisable type the peculiarity of which consists simply in a prodigious disparity in size and solubility between the two parts of the salt molecule. Such are many proteins, some dyes, and soaps, to enumerate them in the order in which they have been investigated. What all colloids do surreptitiously, namely, take to themselves uncovenanted ions, these do in an honest straightforward chemical fashion.

The properties of the class *qua* colloids were, I believe, first worked out by myself in the years 1898–1905, the special case examined being certain proteins, called globulins, which present the added complexity that they combine not only with acids and alkalies to form salts, but also with neutral salts themselves. In spite of this, when the large number of variables was disentangled, the behaviour of the substances was found to be singularly orderly, the phase-rule diagram, for example, being strikingly like that of a commonplace three-component system bearing no suspicion of colloidality.

These colloid salts present one striking peculiarity, namely, that though in water they ionise and hydrolyse on the whole according to the approved pattern, yet one of the molecular species, and that the one which confers upon the solution its most characteristic qualities, is a complex composed for the most part of undissociated salt molecules but with a surface electric charge due to ionisation at the surface.[1] To these bodies I gave the name "colloidal ions." This is strictly accurate notation, for it is because of these complexes that the solutions possess the characteristic colloidal trick of slurring over the obligations of the chemical law of definite and multiple proportions, and they are ions as Faraday used the word, for they wander (ἰόν) in an electric field.

I pointed out that they conformed to Helmholtz's analysis of the condition of electric endosmose, the density of the charge on the surface being constant, and the total charge, therefore, proportional to the surface area. This, of course, obtains only when the solution has had time to forget its past history and to come into equilibrium; waiting for which state needs, in colloidal society, a vast gift of patience.

In the years which followed, much excellent work was done on another example of the group, namely, congo red, by Bayliss, who described aggregates of anions, the total charge being the sum of the charges of the constituents; and still later, a third example, namely, ordinary soap, was investigated by McBain, who rediscovered the colloidal ion but christened it "micelle."

Now accuracy of notation is the breath of the life of science, and to use the word "micelle" for a colloidal ion seems to me to be positively wrong, since the word was introduced by the botanist Nägeli in 1877 to describe something entirely different. Nägeli was a man of a curious imagination but he clothed his dreams in exact language. He is precise as to what he means by "micelle." The word was coined amid a controversy which raged in the 'seventies and 'eighties concerning a distinction then drawn between organised and unorganised colloids and the causes of "swelling."

Nägeli, who was an intellectual heir of the Frankenheim of 1851, began with molecules in 1858, but by 1877 he had identified the unit of the colloidal state as an aggregate of composite type to which he gave the name "micelle." This he supposed to consist of a nucleus of solute surrounded by an atmosphere of bound water. The water atmosphere was the essence of his conception, which had nothing to do with electric charges or with ionisation. A single "micelle," or a micellar chain, contained a micellar nucleus, or nuclei and micellar water. A gel was conceived as being composed of such chains with their micellar water, disposed as membranes or bars to form a sponge enclosing extra-micellar or "enclosed" water.

In complete opposition to Nägeli was Strasburger (1882), a molecularist in the direct line of descent from Kekule. Between stood Pfeffer, whose forebears were Dutrochet, 1827, Nägeli of 1858, Graham, 1864, and Traube, 1867; van Bemmelen had no kinship with Strasburger, he follows on the latest stage of Nägeli (1880) and Pfeffer.

I have just been looking through my thirty-year-old notes of that discussion. What a lot those people knew which is now forthcoming as new knowledge! They knew, or at any rate conjectured, that the colloidal particles were strung together in thread-like masses in some colloidal solutions, and it will do no harm to remind those who propound theories of gel structure that they knew such theories must account for hydrostatic pressures of upwards of 45 atmospheres.

The colloidal ion is far removed from Nägeli's "micelle"; it is nearer to the supposed colloidal unit which Pfeffer called a "tagma," and described as an overgrown aggregate of one species of molecule, namely, those of the solute.

Had recent workers known of these earlier hypotheses they would possibly have been content with the words "colloidal ion" for the constitution of soaps. That brings me to the gist of the matter: in the early 'nineties when, as a physiologist, I was attracted to colloids, I found two schools, both of whom had done excellent work, wholly unacquainted with each other's writing. Ringer, for example, on the biological side had demonstrated on the living heart the differential action of ions and "antagonism." He did not recognise the full significance of his observations because, like all contemporary biologists, he was wholly ignorant of the work of Schulze, and of Picton and Linder. The two schools presently came together to the advantage of both, but now the striking want of acquaintance by many chemists with colloidal work published in the biological journals is symptomatic of a renewed falling apart. How many physicists or chemists know of Mines's brilliant work on membrane potential?

It is impossible to avoid rediscoveries in science because of the enormous burden of knowledge, but it is in every one's interest to minimise them. Out of the mouth of a sinner comes, I hope, good advice. I must be the greatest of sinners myself, for it is certain that no one reads other people's science with greater reluctance than I do.

W. B. HARDY.

[1] A most interesting suggestion as to their structure is that of Adam, in the Proc. Roy. Soc., A, xcix. 336, 1921.

Problems of Hydrone and Water: The Origin of Electricity in Thunderstorms.

THE subject of the electricity of rain and its origin in thunderstorms was dealt with by Dr. G. C. Simpson in a communication to the Royal Society in 1909 (Phil. Trans., 1909, A, vol. 209, pp. 379-413). Taking

Lenard's observations and his own experiments into account, Dr. Simpson concludes that it is not an induced effect, due to an external source; he considers that there is an actual production of electricity in the *subdivision* of large raindrops.

Dr. Simpson's conclusion has long been in my mind. Latterly, the subject has been an attractive one to me, on account of the views I have formed of the composition of water and of the chemical changes attending alteration in the size of drops, referred to in my recent communication to the Royal Society (Roy. Soc. Proc. A, vol. 103, p. 616, 1923). I was much impressed by a lecture at the Royal Institution given early in the year by Dr. Simpson (NATURE, April 14); this, together with a violent hail-thunderstorm which I experienced while yachting in August, led me to look more closely into the problem.

Assuming that water be the cause, the view I should be inclined to take is the converse of that advocated by Dr. Simpson. Granting, for the sake of argument, that changes in water can give rise to free electricity, the fusion of small drops into large would seem to be the more likely process—this being a positive change, in the sense that energy is liberated, while the division of large drops should involve a loss of energy. I assume that the small drops are richer in hydrone than the larger and that changes in composition of the water take place such as I have postulated in my recent communication.

Going further, however, can it be granted that chemical changes *in a wholly liquid circuit* ever give rise to sensible electricity—must not the circuit *be tapped by conducting electrodes* to make this obvious? We must assume that the interactions are primarily electrolytic, but is not the electrical energy, in such cases, always lowered into heat energy?

The question is of fundamental importance, and it is on this account that I make bold to be critical of a solution of a problem outside my field; yet it is one of the borderland issues which chemist and physicist should jointly consider.

Assuming that my interpretation be correct, may not the great rise in potential required to produce lightning have its origin in the coalescence or co-operation of minute drops charged by an external source?

Lenard (*Wied. Ann.*, 1892, 46, p. 584) dealt with the effect, in the first instance, in studying the electricity of waterfalls. His later laboratory experiments led him to the conclusion that it was due to the impact of separate drops upon a flat surface. The water was allowed to splash *into a zinc tray*. Both he and Dr. Simpson found it necessary to use distilled water; that from the mains gave little or no result. The air potential observed was negative, but with a solution of salt it was slightly positive. Up to a certain point, the potential increased rapidly with the length of the jet. Various liquids other than water were tried: the potential varied in sign and magnitude, but the effect was slight as compared with the water effect. Lenard seems to think that the effect has its origin in a contact difference of potential between gas and liquid. All seems to me to point to chemical interchange being at the root of the phenomena and that it is not a mere water effect.

HENRY E. ARMSTRONG.

Earthquake Warnings.

THE recent disaster in Japan demonstrates the importance of endeavouring to ascertain if there are any premonitory indications of a coming earthquake shock which can be recognised and thus enable a warning to be given of its approach.

It seems probable that the rupture, whatever its nature may be, that gives rise to the actual vibratory shock of an earthquake is preceded by a strain or distortion of the earth's crust, which gradually increases till the stress that causes it is suddenly released. The existence of this strain should be evidenced by a progressive sag or tilt of the surface, local and minute in amount, no doubt, but probably sufficiently large to be detected.

In the Milne-Shaw seismometer the vibrations proceeding from distant earthquakes are recorded on sensitised paper on a rotating cylinder by a spot of light reflected from a mirror coupled to the boom of a horizontal pendulum. Ordinarily it is only these vibrations that are taken into consideration, but the same instrument will also indicate a slow tilt of the ground, provided that the exact position of the spot of light can be recorded and measured. In some instruments recently constructed, one of which is being installed in Uganda, this is effected by the use of a second, stationary mirror, which throws another spot of light in a fixed position on the cylinder, and traces a straight line on the record. If there is a tilt of the earth's surface it will be indicated by a variation in the distance between the mean position of the line due to the moving mirror from that of the line due to the fixed mirror, unless of course the tilt is in a direction parallel to the horizontal pendulum. Such an instrument is capable of showing a tilt of $\frac{1}{15}''$ by a movement of the indicating spot of light through 1 mm. If two instruments are employed with their horizontal pendulums at right angles to each other the direction and amount of the tilt will be exactly determined. Near the sea the rise and fall of the tide causes a slow tilt and other changes of a slow periodic character are known, but these can be allowed for and could easily be distinguished from a progressive movement indicating the approaching occurrence of an earthquake in the neighbourhood.

It seems very desirable that such instruments should be installed in localities which are known to be subject to earthquakes.

If it be found that shocks are in fact heralded by a definite tilt, it may be possible to arrange for an electric bell to attract the attention of the observer when such a tilt occurs. If he is satisfied that there is sufficient evidence of an approaching earthquake, a general alarm can be sounded. In this way a warning might be given several hours, or even days, before the shock occurred.

JOHN W. EVANS.

Imperial College of Science and Technology,
S. Kensington, S.W.7.

Human Embryology and Evolution.

IN his reply to Prof. MacBride (NATURE, Sept. 8) Sir Arthur Keith states that in his Huxley lecture he neither affirms nor denies the doctrine of use-inheritance, but that he does deny that Lamarckism has had no part in the evolution of man. If these words were to be taken literally as expressing Sir Arthur Keith's meaning, he and I would be to a great extent in agreement, but it is obvious that the double negative was an accidental mistake, and that Sir Arthur Keith meant to deny that Lamarckism had *any* part in the evolution of man.

I have read the report of his Huxley lecture to the medical students of Charing Cross Hospital Medical School (NATURE, Aug. 18), and it seems to me difficult for an evolutionist to follow his train of thought or reasoning. He does not distinguish between the development of the individual and the evolution of the race, between ontogeny and phylogeny. He discusses the manner in which adaptations appear

during the development of the human embryo, taking as examples the development of the eye, of young nerve-cells, of muscular adaptations. In the adult human leg the peroneus tertius is separate in 90 per cent. of cases, having thus an advantageous position for the performance of its function in walking. In the anthropoid apes this muscle is quite unseparated from the long extensors of the toes. In the developing human fœtus the rudiment of the peroneus tertius separates from the long extensors with which it was originally continuous. To most biologists this would be a typical case of recapitulation.

Sir Arthur Keith says he agrees with Huxley that there are no grounds for believing that the behaviour of embryonic muscle cells is in any way influenced by experiences gained by adult muscle fibres. He then makes the statement that "The evolutionary machinery lies in the behaviour of the embryonic muscle cells or myoblasts," which to me, as it stands, is quite unintelligible. The behaviour of the embryonic muscle cells can explain nothing but the mode in which the adult structure is developed. Such behaviour begins and ends with the individual organism, and cannot possibly contain any evolutionary machinery. It is merely one detail of the complicated embryological changes by which the adult structure is developed. In relation to evolution the question is how are we to explain the fact that the "behaviour of the embryonic cells" is different in the human fœtus from what it is in the anthropoid apes, which presumably resemble the ancestral condition? On this question Sir Arthur Keith says nothing, except the assertion quoted of his agreement with Huxley.

In another part of his lecture Sir Arthur Keith discusses the action of hormones in the course of ontogeny in co-ordinating the development of different parts and tissues. He concludes that more complete knowledge "will reveal in full the true nature of the machinery which underlies the production of structural adaptations which occur in every part of the animal body in every stage of its evolution." Here, again, he is confounding the evolution or origin of the adaptations with their mere development in the individual.

Nevertheless, Sir Arthur, while denying the influence of external influences in human evolution, admits the heredity of "acquired characters" and even injuries in certain cases. He states that Lamarckism cannot explain the characters which differentiate one racial type of modern man from another. On this last point I am entirely in agreement with him, for Lamarckism is a theory of the evolution of adaptive characters, and racial characters of man are for the most part not adaptive.

I should like in conclusion to contrast two passages in Sir Arthur Keith's lecture. He writes, "Nothing is better known than that, if a bone of a rickety child bends under the weight of the body, the bone cells lying in its concavity will proliferate and build a buttress to strengthen the shaft." The bone cells "react to fulfil an end necessary for the occasion." This seems to me quite inconsistent with the statement, "there are no grounds for believing that the behaviour of embryonic cells is in any way influenced by experiences gained by adult muscle fibres." The first of these two passages admits the *reaction* of the tissues of the body to external stimuli, while the second passage and the whole tendency of the lecture apparently denies the occurrence of such reaction.

J. T. Cunningham.

Chiswick, W.4,
September 11.

Curious Spherical Masses in Ashdown Sands.

Mr. Harry E. Burns, of Crowborough, this spring informed me of some remarkable spherical masses of sandstone in the Ashdown Sands at High Hurst Wood Quarry, and was good enough later to supply one about 10 inches in diameter to our Museum. He suggested that they might be sand casts of reptilian eggs like that of the Iguanodon. They consist of fine-grained nearly white stone—much of the iron having been leached out. I expected but failed entirely to find on section any pan or stains of limonite such as in the well-known balls of Folkestone Sands.

Recently I have visited the quarry with Mr. Burns, and was able to see a ball 30 inches in diameter in position. We were told they are confined to an upper bed about 14 feet thick, and vary in size from 10 to 30 inches in diameter. We could discover no evidence

Fig. 1.

of a foreign body or of concretionary growth, although such growths are not rare in the Wealden Sandstones—often, too, in a decalcified condition. Those at Crowborough are found loose in a narrow cavity, and the stone appears identical in colour, etc., with that of the surrounding bed. The adjacent stone for a few inches is shattered—due, I suppose, to the pressure of overlying beds against the unyielding sphere, while the narrow clefts are filled with clay, doubtless washed there from the once overlying Wadhurst Clay. Strangely enough, some of these balls have been used as ornaments at the tops of wooden gate-posts! During the forty-five years I have lived in the neighbourhood I have not met such masses before, and find them difficult to explain. The photograph (Fig. 1) shows a group of these stones taken by Mr. Burns, who kindly allows me to use it.

Geo. Abbott.

2 Rusthall Park, Tunbridge Wells,
September 10.

Stereoisomerism among Derivatives of Diphenyl.

Dr. Turner's remarks (Nature, September 22, p. 439) appear to have been made without his having seen my letter of some eighteen months ago (Nature, May 6, 1922, p. 581), which was concerned with the importance of stereoisomerism among diphenyl derivatives in relation to Sir William Bragg's conclusions as to the molecular structure of benzene in the crystal. At that time, reasons for reviving the Dewar para-linkage formula for benzene had not been published (Ingold, Trans. Chem. Soc., 1922, 1143), but since this bridged formula "is stereochemically

identical with the disposition of atoms suggested by Sir William Bragg for the molecule of benzene" (Challenor and Ingold, Trans. Chem. Soc., 1923, 2068), it will scarcely be maintained that Dr. Turner's suggestion of a possible stable para-linkage in diphenyl derivatives introduces any essentially novel consideration to the question of the structure of these compounds. I also referred in my letter to the remarkable behaviour of diphenyl towards ozone, mentioned by Dr. Turner, as well as to certain other noteworthy properties of the compound.

It should perhaps be pointed out that although, as Dr. Turner states, the formula considered by him contains four asymmetric carbon atoms, it would be incorrect to suppose that it therefore demands the existence of a correspondingly large number of stereoisomeric forms of 2 : 2′-derivatives of diphenyl. For the respective distributions of the groups attached to the pair of asymmetric carbon atoms in either benzene nucleus are not mutually independent, so that only one asymmetric atom in each nucleus is effective as a source of stereoisomerism.

In conclusion, I need scarcely say that experiments on the isomerism in question are being actively prosecuted in this laboratory, and are by no means limited to 2 : 2′-derivatives of diphenyl.

J. Kenner.

The Chemical Department, The University, Sheffield, September 25.

Waves and Quanta.

The quantum relation, energy $=h\times$ frequency, leads one to associate a periodical phenomenon with any isolated portion of matter or energy. An observer bound to the portion of matter will associate with it a frequency determined by its internal energy, namely, by its "mass at rest." An observer for whom a portion of matter is in steady motion with velocity βc, will see this frequency lower in consequence of the Lorentz-Einstein time transformation. I have been able to show (*Comptes rendus*, September 10 and 24, of the Paris Academy of Sciences) that the fixed observer will constantly see the internal periodical phenomenon in phase with a wave the frequency of which $\nu=\dfrac{m_0c^2}{h\sqrt{1-\beta^2}}$ is determined by the quantum relation using the whole energy of the moving body—provided it is assumed that the wave spreads with the velocity c/β. This wave, the velocity of which is greater than c, cannot carry energy.

A radiation of frequency ν has to be considered as divided into atoms of light of very small internal mass ($<10^{-50}$ gm.) which move with a velocity very nearly equal to c given by $\dfrac{m_0c^2}{\sqrt{1-\beta^2}}=h\nu$. The atom of light slides slowly upon the non-material wave the frequency of which is ν and velocity c/β, very little higher than c.

The "phase wave" has a very great importance in determining the motion of any moving body, and I have been able to show that the stability conditions of the trajectories in Bohr's atom express that the wave is tuned with the length of the closed path.

The path of a luminous atom is no longer straight when this atom crosses a narrow opening; that is, diffraction. It is then *necessary* to give up the inertia principle, and we must suppose that any moving body follows always the ray of its "phase wave"; its path will then bend by passing through a sufficiently small aperture. Dynamics must undergo the same evolution that optics has undergone when undulations took the place of purely geometrical optics. Hypotheses based upon those of the wave theory allowed us to explain interferences and diffraction fringes. By means of these new ideas, it will probably be possible to reconcile also diffusion and dispersion with the discontinuity of light, and to solve almost all the problems brought up by quanta.

Louis de Broglie.

Paris, September 12.

The "Concilium Bibliographicum."

In the commentary added to my letter concerning the "Concilium Bibliographicum" which appeared in Nature of June 30, p. 880, some doubts were expressed regarding the continuous appearance of its cards. May I be permitted to emphasise again that our cards are issued and delivered as heretofore to our subscribers.

Another publication of the Concilium is the "Bibliographia Zoologica," of which volumes 30 and 31 have been published and vol. 32 will be sent out shortly, indicating definitely that this zoological bibliography is not a new undertaking of the Concilium.

No doubt it is a rather complicated question to decide whether or not this zoological bibliography in book form is a duplication of the "Zoological Record." It must be recalled that apart from completeness, promptness, and accessibility, carefulness and the procedure in the arrangement of the bibliographical work play a very important rôle. Indeed, as for every application of scientific procedure, it is not only the tools but also the degree of ability to use them which governs the appreciation of those who have to work with them. One works better with one method, another is more adapted to the use of another. To all these points have to be added as important factors the influence of different education and local tradition.

In making a plea for a co-operation between the "Zoological Record" and the bibliographical service of the Concilium, a condition which unquestionably could be of real value to the zoological world, the writer wishes to suggest that these various important points of internal character be seriously considered.

When it was decided in 1921 to continue the book-form of the "Bibliographia Zoologica," the material to be published was so extensive that it was impossible to treat the whole animal kingdom in every volume. But this is certainly not a misfortune, for it is evident that a bibliography of titles has not only an immediate value, but also represents to a great extent a source for continuous reference.

J. Strohl,
Director of the "Concilium Bibliographicum."

Zurich.

Long-range Particles from Radium-active Deposit.

In the letter which appeared in Nature of September 15, p. 394, under this heading, by Dr. Kirsch and myself, there are two errors which obscure the sense of our communication. The maximum range of the H-particles expelled from silicon should read 12 cm., the corresponding number for beryllium being 18 cm., instead of vice versa. The last sentence should read: "Our results seem to indicate that an *expellable* H-nucleus is a more common constituent of the lighter atoms than one has hitherto been inclined to believe," the word in italics being omitted in the printing.

Hans Pettersson.

Göteborgs Högskola, Sweden.

[The transposition of the values 12 cm. and 18 cm. was the fault of our printers; and we much regret it. The omission of the word "expellable" was due to the authors, who did not include the word in their letter. Two separate proofs of the letter were sent to Dr. Kirsch at Vienna, but neither was returned.—Editor, Nature.]

The Management of Medical Research.[1]

By Sir RONALD ROSS, K.C.B., K.C.M.G., F.R.S.

TWENTY years have now elapsed since I had the honour and pleasure of addressing Anderson's College Medical School at the opening of its winter session of 1903. This is, indeed, only a short interval in cosmic time; for—to use a figure which will exhibit the rapidity of scientific advance nowadays—all these years amount only to twenty vibrations of the electron which we call the earth round its nucleus the sun, in this atom which we name the solar system! However, for us it has been a considerable period. Many of those who faced me twenty years ago as students are now placed in the seats of the mighty, and will, I hope, support what I have to say to-day. Alas! two of the faces with which I was then familiar are missing—Prof. R. S. Thomson, dean of the Medical Faculty, and Sir James Marwick; some of the distinguished men who were helping us—Dr. Laveran, Dr. Robert Koch, Sir Patrick Manson, Sir William Osler, Lord Lister, Sir Alfred Jones, Sir Rubert Boyce—are no more; and, above all, I must mourn that great pupil of the School, a ruler of many Colonies, and my own master, friend, and supporter, Sir William MacGregor.

On that occasion my address was entitled "Medical Science and the Empire," and in it I described the efforts which we were making to reduce malaria in British possessions. Four years previously we had verified, corrected, and completed the old conjectures that malaria is carried in some way by mosquitoes; and three years previously the Americans had proved the similar conjectures regarding yellow fever. Schools of Tropical Medicine had been established in Liverpool and London, and were about to be created in many parts of the world. At that time I myself hoped that malaria would be banished in a few years from all our principal cities in the tropics; and I had visited West Africa from Liverpool on three occasions for that purpose. I shall never forget the assistance rendered during my second and third visits by two Glasgow men, the late Mr. James Coats, who gave us two thousand pounds to start our anti-malaria work in Sierra Leone, and Dr. M. Logan Taylor, who remained in West Africa for two years, carrying out the practical measures and trying to persuade the local authorities to continue them.

My address—which I believe was not published, but which I still possess—was full of that morning enthusiasm. I argued that the time had already come when medical science could revolutionise the tropics; when it could render them worth living in by banishing the great endemic diseases which overshadowed them; when it could assist civilisation (coming from the temperate regions of the earth) to conquer the rich regions of the Sun and of the Palm. I even dared to quote the great words of the poet regarding Columbus, that he

> "Gave to man the godlike gift of half a world;"

and I hoped that we should be able to do the same. This had been the faith which had compelled us—others besides myself—for many years: not to add to abstract science, not merely for the sake of parasitology or entomology, not to compile text-books or to fill libraries; but to help the sick and the dying—millions of them—and so to open up the world. When I last spoke to you I hoped that all this was going to be done in a year or two! I am wiser now. Kipling says that we must not try to hustle the East; so, I have found, we must not try to hustle the West either! Men think slowly. It requires a new generation to understand a new idea, even the simplest one.

Some notable advances have, however, been made. Mosquito-reduction against malaria was first urged and defined by us in Sierra Leone in 1899; and was commenced there by Logan Taylor and myself two years later in 1901, and, almost simultaneously, by the Americans under W. C. Gorgas in Havana, and by Malcolm Watson in the Federated Malay States. In 1902 Sir William MacGregor and I visited Ismailia on the Suez Canal—with the result that malaria was banished from that town within a few months. Then the Americans commenced the construction of the Panama Canal, with Gorgas as chief of their sanitary staff, and kindly asked me to visit Panama in order to see them at work in 1904. The result is well-known—the Canal is now finished, with a minimum loss of life. But you are probably not so familiar with the equally great work of Malcolm Watson in the Federated Malay States—because it is merely a British achievement! For more than twenty years he and his friends have fought on against King Malaria and all his allies—rain, heat, jungle, marsh, and ignorance—and is gradually winning forward, step by step. While Gorgas had behind him the full official support of the wealthy American nation, Watson and other British workers in this line have been mostly obliged to rely only upon private initiative and such small funds as they could rake together for their purpose. Not less important has been the work of the entomologists, from F. V. Theobald onwards; but I am not now narrating the history of this movement, or I could speak of many other brave efforts made during these last twenty years. Not perhaps quite as much as I had hoped for, but still something. What may be called "economic sanitation" among our troops, our officials, and our large and numerous plantations, has been greatly improved, and thousands of lives and thousands upon thousands of cases of sickness have been saved. Perhaps, even already, we may echo the words of the Duke of Wellington: "Yes, 'twas a famous victory."

During the same period science has won or is winning many other victories as great. As regards tropical medicine, we have been advancing against plague, cholera, typhoid, sleeping-sickness, kala-azar, hook-worm, beri-beri, bilharzia, and leprosy; and as regards the diseases of temperate climates, we have diminished child-mortality, diphtheria, tuberculosis, numerous ailments due to local infections or to physiological insufficiencies, such as myxœdema, and, quite recently, have inflicted a defeat upon diabetes. We

[1] An address delivered to the Anderson College of Medicine, Glasgow, on October 9, at the opening of the winter session.

are getting on. How? By patient, obstinate, and ineluctable investigation—not in the fields of medicine only, but also in those of physics, chemistry, and zoology. Finally, it is just here that we have scored our greatest victory—against our own stupidity. We, or let us say the public outside these walls, are at last beginning to learn that investigation really matters: we are discovering discovery!

It was not always so, even among doctors. I remember a medical administrator saying, "I cannot keep a number of men idling about here with microscopes," and a High Commissioner exclaiming, "You say you do not know how to manage this outbreak! Surely you medical men *ought* to know." He seemed to think that all we had to do was to consult the Hippocratic Books. The idea that investigation is an essential part of practice has been of very slow growth. In India, when a European doctor was asked to cure a lady of the zenana, he was at one time not allowed to see her, and she was not permitted to do more than put out her tongue at him from behind a curtain. A distinguished English physician, who was, I believe, connected with my own family, is said to have deprecated all clinical examinations: we should know how to cure by instinct. To the public mind the physician loses caste by "wanting to know." He must practice, he may teach, but he should not require to investigate anything!

It has taken us centuries to free ourselves from the serpentine coils of this prejudice and to reach our present position—where investigation is the key-industry of all industries. The evolution of this revolution is interesting. The ancient Greeks certainly valued, not only practice and teaching, but also discoveries when made; yet we are not aware that they ever explicitly organised or encouraged research. Readers of the history of science often wonder how the old philosophers and geometers managed to live at all—probably by teaching and possibly on patronage or charity. They were private enthusiasts, and their fundamental discoveries do not appear to have been rewarded in any way. I am told that it is not known whether Plato demanded fees, as well as a knowledge of mathematics, for admission into his Academy; and the same may be said, I understand, regarding Aristotle's Lyceum. Several of the mathematicians, such as Eudoxus of Cnidos, appear also to have been practising physicians. It is to be presumed that the Museum at Alexandria was in essential particulars like a modern university, where teaching is the official duty of the staff, but where research and practice may be conducted at option between the lectures and classes, often with the assistance of students. We are told that after the collapse of the ancient empires and about the time of William the Conqueror, when Europe was plunged in darkness, the Arabs in Spain possessed a library of 600,000 volumes, an academy, and a fund for the endowment of learned men, probably employed for teaching.

Europe did not advance so far as this for centuries, but the monasteries maintained many learned monks, such as Roger Bacon, with whom the new dawn of science commenced. The great Italian anatomists of the sixteenth century were either practising physicians or members of universities. I think that the first real "research institute," subsidised by public and private funds for pure investigation only, was the famous Uraniborg of Tycho Brahe, founded in Denmark in 1576. It well subserved the proper purpose of such institutes, which is the collection of numerous and exact observations and measurements that are beyond the power of private investigators. Tycho Brahe brought no new integration into astronomy, and even opposed the fundamental theory of Copernicus; but his data enabled Kepler and Newton to revolutionise the science. It is interesting to note that Copernicus himself was only a "private enthusiast," a man of affairs, and a physician; and also that after twenty-one years the politicians stopped their subsidy for Uraniborg, as Mr. Alfred Noyes has described so pathetically in his fine epic of science, "The Torch Bearers." In those days the greatest men were often obliged to pick up a living as best they could—even by the use of alchemy and astrology. Kepler said sarcastically that "Mother Astronomy would surely starve but for the earnings of her daughter Astrology." Even in the observatories and museums which began to be founded after Uraniborg, official duties must have greatly interrupted investigation.

Thus we see that at all times, as often to-day, science has been compelled to get her living by more lucrative but less important pursuits, especially teaching and professional practice. Last century, however, the idea of special research institutes was taken up again with vigour, and the Pasteur Institute in Paris, the Jenner Institute in London, and a score or more similar foundations were established in most of the world's great cities, sometimes by private benefactions or bequests, sometimes by State subsidies, and often by both. Here we find a new principle at work—that of maintaining skilled investigators for research only, apart from teaching and practice. Allied to those, we now possess numbers of industrial research laboratories employed by commercial companies on the improvement of agriculture or of manufactures—and we know what America and Germany have done in this line. Then, again, our hospitals now possess laboratories both for clinical pathology and for research; while the professorial laboratories in all departments of science at our universities have been greatly enlarged and improved, though teaching is still, and quite properly, a part of their duties. Yet another advance is that of research scholarships, by which numbers of promising students are now employed for a few years on such investigations as attract them.

Lastly—and at very long last—the State itself has now joined in the pursuit of truth by means of large annual subsidies, such as those which are distributed in Great Britain by the Department of Scientific and Industrial Research and the Medical Research Council. It would be a difficult task to form even a rough estimate of the world's present expenditure on subsidised research. I think it must reach quite a million pounds a year. This is a small sum compared with the world's expenditure on armaments or education; but it is an improvement on the time when Socrates was obliged to argue in the market-place or Diogenes to fulminate psychoanalysis from a tub.

The improvement has been greatest in connexion with medical investigation. It was not so many years

ago that an American who had studied the matter told me that the world then possessed many fewer endowed professorships on pathology and hygiene than on Sanskrit, philosophy, and theology. This was rather surprising. Every one in the world is certain to suffer from some malady at least once; but no one need suffer from Sanskrit or philosophy unless he pleases, nor even from theology—during this life. But there has always been a thin vein of unreality in academic affairs. Now, however, even Sanskrit is beginning to pale before cancer. On the other hand, so recently as last June, I saw the announcement that the chief countries of the world contribute annually an average income of 9,594,254*l.* to the various Protestant Foreign Missions. This is nearly ten times the amount which I conjecture the world is now giving for the whole of its scientific investigations in all fields. North America gives to the Missions an average of 6,327,597*l.* a year and Great Britain gives 2,310,000*l.* a year; Germany has dropped out owing to the fall of the mark, but other countries contribute the balance. We are not jealous, but our mouths water at the thought of these vast sums. On one side, the missionaries, from your great *alumnus* David Livingstone onwards, have been the pioneers of civilisation and have done great work. On the other side, we think of the millions of people now dying prematurely every year of diseases which are probably easily curable or preventable, though we do not know how to cure or to prevent them at present.

On the whole, I think that the war-funds of science are likely to go on increasing year by year as the public becomes more and more convinced of results. The fundamental question is therefore now being asked, How best should we spend the money? Remember that, as I have shown, the endowment of investigation apart from teaching is only a recent innovation, and probably, like all new methods, has not yet been perfected. How can the best results be obtained for the least expenditure? The question must ultimately be decided by you young men: for us it remains only to attempt a preparatory analysis.

Regarding *medical* research there are two schools of opinion, which we may call the *Bulls* and the *Bears*. One school, the Bulls, say: "We must spend every penny we can raise on constant investigations managed by capable committees and carried on by trained research workers, maintained if possible for life in order to be sheltered from the necessity of teaching or practice, and provided with the most up-to-date laboratories, plenty of materials, and easy access to scientific literature. It is true that some money may thus be wasted, that some of the results may prove wrong, that some of the workers may not turn out so capable as they were thought to be: no matter. A single great success will be worth all the money that is likely to be spent in this way. Pour out the cash; catch all the young men you can and set them at their measurements and microscopes, and keep them at it as long as they are willing to stay. The larger the number of seekers the larger the number of finders. Drop the failures, cut the losses, and think only of the profits." To them the other party, the Bears, reply: "You can spend what money you like but you cannot buy discovery. All that your managing committees and trained investigators are likely to do or achieve will be the study of details along already well-trodden paths. They will inoculate legions of rats and guinea-pigs, and will publish profound but incomplete papers every quarter, which will be of little or no use in practice. They will carry out researches—yes, academic researches, and too many of them! But the world does not ask for researches; it asks for discoveries—not for the incomplete but for the complete article. Has a single great medical discovery been made by managing committees and subsidised investigators? Discoveries are made by genius—and that you cannot buy."

Such are the opinions which one hears on both sides. Personally I agree and yet disagree with both. There is only one way to decide. Research and discovery are themselves natural phenomena, and we should study them scientifically. I said we have discovered discovery: let us also investigate investigation. How? By consulting the great and triumphant history of science, particularly the stories of the chief advances. If we do so we shall see that the two parties are merely quarrelling over the two faces of the same coin. Science proceeds, not in one, but in two ways: first by collecting facts and then by basing inductions upon them. Thus, in the classical example already cited, it was Tycho Brahe who spent his life in collecting trustworthy observations regarding the positions of the heavenly bodies, but it was his pupil Kepler who, after twenty-five years' study of Brahe's figures, established the great induction that all the planets move in similar elliptical orbits round the sun; and it was Isaac Newton who, eighty years later, explained all these orbits by the single law of universal gravitation. That is, one man collected the facts, but other men explained them. For a second example: by the middle of last century numbers of workers, including Buffon and Linnæus and a host of private enthusiasts and amateurs, had observed, distinguished, and described innumerable kinds of plants and animals; then came Darwin, who explained these facts—much more numerous than he could ever have collected single-handed—by his theory of natural selection. For a third example: think of the host of physicians, surgeons, and apothecaries who have studied and described the characters and symptoms of human maladies without being able to explain them. Then came Semmelweiss, Pasteur, Lister, and Koch, who created bacteriology.

Certainly observation and induction have often worked together in the same research, with brilliant results. More often they pull different ways and break down. Every one knows the man who begins with his induction and then fits his facts to it—or thinks he does. On the other hand, the "working hypothesis" frequently suggests invaluable, though possibly negative, experiments. Then we have the men—generally young men—who make a new generalisation with every new observation: I was one of them once. Often, however, observation and induction require very different faculties, which belong to different men, often living in different ages. If we were all Newtons there would be no problems left to solve.

Science needs all the faculties—the eye of one man, the hand of another, and the brain of a third. Observa-

tion is at least as necessary to it as induction. Therefore I do not agree with the party of the Bears when they depreciate subsidised investigations carried out by full-time workers under managing committees. The present state of medical science requires constant physiological, pathological, therapeutic, and biochemical researches, often involving delicate measurements which cannot be made by medical practitioners outside laboratories, or even by teachers in the medical schools in their spare time. Spend therefore as much money as you can raise for this purpose; let every budding Pasteur have his chance; and pray for a Rockefeller. But at the same time considerable waste must be expected and allowed for. One does not envy committees of management. As Sir Ernest Rutherford recently said in his address to the British Association: "Those who have the responsibility of administering the grants in aid of research for both pure and applied science will need all their wisdom and experience to make a wise allocation of funds to secure the maximum of results for the minimum of expenditure. It is fatally easy to spend much money in a direct frontal attack on some technical problem of importance when the solution may depend on some addition to knowledge which can be gained in some other field of scientific inquiry, possibly at a trifling cost."

I can adduce many other difficulties. Workers are apt to be called away to other posts before their task is complete. Then who can know when an old vein is exhausted, or whether a proposed new line is really promising, unless he himself has worked at the job?—and few committees can consist of specialists in all possible lines. In my own subject I have known men employed who had never read the literature, who dug up again old disused workings, or who chased the wild goose with a pinch of salt for years—all costing money. But the greatest waste is caused by the large number of incomplete articles, constantly being published, which, though they may be good so far as they go, are lost in the mass of literature—so that when the man who clears up the question finally arrives he is obliged to rediscover all the matter for himself. But in spite of these difficulties I agree with the Bulls. The world must continue spending money in this way; and it will improve the system with practice.

Now for the other side—the obverse of the medal. One of our most distinguished physicians told me a few months ago that some one had accused him of not really being a man of science because he did not work in a laboratory! Yet he has made more valuable additions to medical knowledge and practice than has fallen to the lot of most laboratories. Consider this point carefully. The work of the laboratory has almost always been the collection of facts and measurements, the elaboration of detail, the testing of theories; but the other side of science, the great inductions which have solved problems or have applied facts directly to the cure or prevention of disease have been made mostly by that humble individual, the "private enthusiast"—generally either a teacher or a "mere doctor." William Harvey was a mere doctor; Edward Jenner, a mere country doctor! What laboratory did Jenner require? He did not even use a microscope, and yet he gave to humanity the greatest single boon which it has ever received, and also initiated our present knowledge of immunity. G. F. E. Küchenmeister, who first proved alternations of generations in parasites, was a practising doctor. Pasteur was a professor of chemistry. Lister was a practising surgeon in Glasgow. Robert Koch was also a mere practising country doctor when he discovered the bacilli of anthrax and of surgical sepsis, the staining of bacteria, and plate-cultivation, thus making practical bacteriology. Manson was a doctor in China. Laveran, Bruce, Reed, and Leishman were or are army doctors. Need I mention any more names?—I should have to hurl almost the whole history of medicine at you! Where were the laboratories of these men?—in their own hospitals and consulting-rooms. Where were the laboratories of Kepler and Newton?—in their own brains. Who are making the innumerable advances which we see to-day in connexion with medical, surgical, and sanitary practice regarding almost all diseases? Very largely our professors, our teachers, our laboratory workers, it is true; but also, and not less, our clinicians and our hygienists.

We see then that there is much to be said for the Bears as well as for the Bulls. It is an historical fact that most of the greatest advances have been made by men who were not subsidised for their researches. I think, therefore, that the whole field of public support for science should be broadened so as to include such men. At present the public gives considerable sums for institutional investigations with the test-tube, the scalpel, and the microscope, but little or nothing for workers outside. That is, it supports, and rightly supports, observational science, which is largely ancillary, but scarcely helps those great intellectual investigations which mostly obtain the final or useful results. It would have subsidised Tycho Brahe's observatory at Uraniborg; but it would probably have refused a penny to Kepler, or to Newton, or to Jenner. It pays for digging the foundations of the Temple of Medical Science, but leaves the building of the walls and towers to the practitioner and the enthusiast—often at their own cost. It pours out money for the expectation of discoveries to come, but refuses to give anything for discoveries already completed by private individuals!

It seems to me that all this is very "bad business." We should pay not only for expectations but also for results. I should like to see the whole medical profession brought into the research fold—not in laboratories, but in their practice, their consulting-rooms, and their own brains. Some one will say that the private enthusiast will continue to work whether we help him or not—surely the meanest argument ever used!—but will he? Then some one else will exclaim that there is nothing to hinder any and every medical man from investigation. I am not so sure. True, hundreds or thousands of them are now actually thus engaged, and, in fact, are obtaining the important results just mentioned; but large numbers of medical men cannot always afford such a luxury, because they have to maintain their practices. The reason for this is that while clinical researches which improve medical and surgical treatment often *enhance* practice—and very deservedly so—other scientific work, such as physiological and pathological studies, which are off

the main lines of clinical research, often notoriously *injure* practice. There is still a feeling that a man will not be "a good doctor" if he takes to flying the scientific kite too often. Thus every one knows that both Harvey and Jenner ruined their respective practices by their scientific studies. For another example, it was said of Thomas Young, the father of physiological optics and discoverer of many great theorems on light, heat, and energy, that he "was not regarded as a successful practitioner, because he studied symptoms too closely, although his treatment was admitted to be effective." In other words, he cured his cases by studying their symptoms instead of studying the correct bed-side manner! Wise or not, this feeling has to be considered by practical men. Then there is a third class of effort—perhaps the very highest class of medical work—which is concerned with the prevention of the great epidemic diseases. At present it receives no payment whatever, either from practice or otherwise. What has been done, for example, for Mr. W. M. M. Haffkine or for Mr. H. E. Hankin—both laymen and private enthusiasts—whose studies have saved untold numbers of lives from cholera and plague in India and elsewhere; or for the almost unknown doctors who discovered that plague—the world-destroying plague—is carried by the rat-flea?

Such drawbacks, and others, are unfortunate, because they tend to impede enlistments in the great voluntary army of medical science. Our friend the private enthusiast is a rare species; and the successful enthusiast is very rare indeed. You cannot subsidise him beforehand, because you cannot discover him until he has *done his work*. You can supply him with laboratories, test-tubes, and microscopes—if he wants them, but you cannot pay him for his thoughts, his calculations, or his natural aptitude, nor, above all, for that passion for discovery—for discovery not merely for investigation—which drives him over every obstacle to his ultimate goal. You cannot subsidise him, and you cannot reward him either. It is beyond the power of the whole earth to reward him; his discovery is his reward. But still you can do something for him in a small way. In 1802 and 1807 Parliament compensated Jenner for the loss of his practice; in 1884 the German government did the same for Robert Koch; and quite recently, I understand, the Canadian government has, very wisely, shown the same consideration to Dr. Banting for his brilliant labours on insulin.

The *least* that the world can do for the successful investigator, whomsoever he may be, is to pay honourably such of his little out-of-pocket expenses and losses as he may have incurred in the world's service; and the *most* that the world can do for him is—to keep him at work. This is the way in which money can now be most profitably spent for science. I see that Sir Alfred Yarrow has recently given a fine donation, which is to be devoted partly to this purpose. If I were a millionaire I should follow his example.

It is often said that there is no such thing as discovery, that each advance is built upon previous advances. True; but what is the interval between these advances? Many people carry on incomplete investigations, and just miss their triumphant culmination. The culmination is the discovery. I have often wondered how it was that those wonderful people, the ancient Greeks, missed four great discoveries which they seem to have been on the point of achieving—the calculus, evolution, electricity, and vaccination. As it is, the world was obliged to wait for nearly two thousand years before these little "advances" were made. It awaited the proper men. Only the other day an able biochemist told me that probably most of the facts regarding the complicated diseases of metabolism are already known, but that another Newton is required to integrate them. Such, I think, may also be the case regarding other grave medical problems, as, for example, that of cancer. Possibly the discovery may already be made, but there is no one to drag it forth into the light. In science, as in art, the man is everything.

I must make one more remark. What always amazes me is the fact that there are millions upon millions of human beings whose health and whose very existences are constantly threatened by numbers of diseases, and yet who never subscribe one farthing for the medical researches which endeavour to defeat these terrible enemies of theirs, and often succeed in doing so. Yet thousands of these same people pour out their subscriptions and bequests for all kinds of projects, many of which are futile; while even those good and generous people who maintain our hospitals and universities seem often to forget that behind hospital practice and behind university teaching there is th great science which inspires both.

I have tried to give you a brief review of what may be called the natural history of discovery. "The management of medical research" will lie in the hands of you young people; but you must study the book of the past in order to direct the advances of the future. I hope that most of you will be "mere practising doctors"; but, if so, let every afferent and efferent nerve of your thoughts connect the brain of science with every sense, muscle, and faculty of your practice. The practitioner nowadays cannot live apart from science, trying to evolve wisdom from his own meditations, like a hermit in the desert: you must not only observe, but also think; and not only think, but also read. Your first duty will be the cure or prevention of sickness; but some of you in your leisure may perhaps try to solve problems, may become enthusiasts, may even become wild enthusiasts!—I cannot imagine a nobler fate. Even, perhaps, one of you—probably not more—may be destined to become the Newton or Einstein of some hitherto undreamed-of synthesis. I hope so.

Science has indeed measured the stars and the atoms, has knit together the corners of the earth, and has enabled us to fly over oceans and deserts; but her greatest victory remains to be won. Why should we men, heirs of all the ages, continue to suffer from such mean things as diseases? Are you going to be defeated any longer by bacilli, rat-fleas, and mosquitoes? It is for you to conquer them; and remember that every gift of science is a gift not to one country or to two countries, not only for to-day or for to-morrow, but also to the whole world and for all time, until, as the poet said,

"The future dares forget the past."

The Recent Eruption of Etna.

By Prof. GAETANO PONTE, of the Etna Vulcanological Institute.

DURING the last ten years Etna has exhibited various phenomena of considerable interest, especially at the lateral crater which appeared in May 1911 on the north-eastern slope of the central cone at the 3100 metre contour. This was the forerunner of a more violent eruption in September of 1911, when the new north-east crater became more active than the central one.

In 1917 a luminous column rose like a fountain a thousand metres above the north-east crater, and about 50,000 cubic metres of very fluid lava were poured out in about half an hour, without either rumblings or shakings of the ground. This afforded most striking proof of the resistance of the structure of the volcano to the enormous forces propelling the lava, which was raised not by the force of volcanic gases, but by powerful static pressure.

In June 1922 the activity of the north-east crater was resumed, and there were feeble explosions. In the spring of 1923 its activity increased still more, and at the foot of the explosion-cone which had been formed, some streams of lava appeared and spread out in short many-branched flows over the snow-fields. It was very interesting to observe the phenomenon of the hot lava spreading over the snow without melting it, but rather transforming it into ice under the weight.

The activity of the north-east crater continued until the outbreak of the eccentric eruption, which was preceded by the great explosions in the central crater, where, on June 6 last, the throat of the volcano, obstructed since 1918, reopened and ejected gigantic pine-tree clouds of reddish ash to a great height above the crater.

Following this the sky remained obscured for many days, and observations became impossible. At 2.30 A.M. of June 17 the inhabitants of the northern slope of the volcano were rudely awakened by deep rumblings and shakings of the ground, while near the craters of 1809, at the 1500 metre altitude, there rose imposing outpourings of lava; meanwhile other craters opened and other streams ran lower down the mountain, until at 4 A.M., at the 2000 m. contour on the western slope of Monte Ponte di Ferro, and at the south-western foot of Monte Nero, there were established definitely the craters of the main flow. The flow of Monte Nero, which was feeble and of short duration, ran over the bed of the 1879 lava for about 3 kilometres, but the mouth from which it flowed closed on June 21, whereas the flow from Monte Ponte di Ferro, which was of much greater extent, invaded the pine-forest of Petarrone, and, rapidly running down the eastern side of the lava-flow of 1911, reached in a few hours the Piano dei Filici, where, spreading its front, it headed towards Cerro and destroyed the vineyards and the nut-plantations of the Piano di Pallamelata (see Fig. 1).

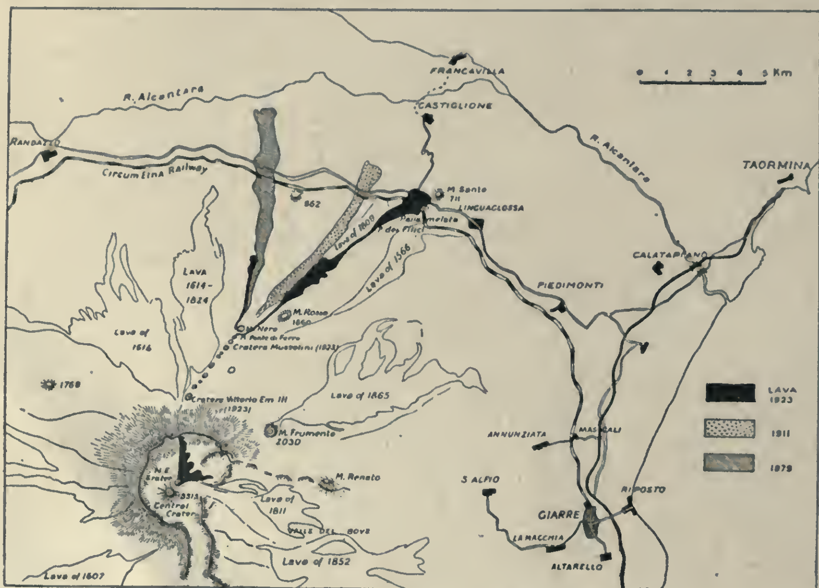

FIG. 1.—Sketch-map of north-eastern part of Etna, showing track of lava.

In ten hours the lava had travelled about 7 kilometres, falling in that distance 1200 metres, but as soon as it reached the plain, as has happened in other eruptions of Etna, it slackened the speed of its advance, spread fan-wise, and swelled like the carapace of a tortoise. Thus it happened that the front of the lava, which on the evening of June 17 was about 1 kilometre from the Circum-Etna Railway, reduced its speed, and did not invade the station of Castiglione until the night of June 19.

On June 20, when the King of Italy arrived in the region devastated by the lava-flow, the front was already 1 kilometre in width, and was still advancing at a speed of from 10 to 15 metres per hour. On the following day, when the Premier, Signor Mussolini, arrived, the flow had reached the foot of Monte Santo and continued to spread out slowly like a fan, enveloping the last few houses of the Catena suburb and threatening the town of Linguaglossa. Fortunately, however, from that day the impetus of the lava began slowly to diminish, and by June 26 its rate of advance was reduced by a half. The front of the lava-flow, not being sufficiently fed from its source, stopped definitely on June 29, but on the Piano di Pallamelata, on the eastern side of the flow, a fresh branch was formed, which at first threatened to give a new direction to the devastating torrent. In the meantime, higher up on the lava-flow there were further additions and lateral outbreaks. At some points the crust of lava

formed blisters, some of which, becoming solidified and remaining hollow, finally crashed in, owing to the lateral fissures. The emission of lava continued slowly until July 18, when the fiery torrent appeared to have solidified in the crater-mouth. The area covered by the lava is about three square kilometres, as estimated from the photographs taken by me from the hydroplane M. 28, kindly placed at my disposal by Signor Mussolini.

From the phenomena observed during the eruption, it can be seen that its progress was in direct relation to the mass of the lava emitted, and the various incidents were the consequences of special local conditions. If the structure of Etna were homogeneous, that is to say without hollows or fissures, the molten lava would not have departed from its principal eruptive conduit, and the eruption would have developed in the central crater. The passages which abound in the lava-flows on the slope of the volcano represent, however, so many subterranean routes which the molten lava could follow through a breach in the principal conduit, which might be formed by the simple collapse of weak parts of its walls or by breaking through where the rock was corroded by acid vapours. We do not know the changes that may have taken place along the epi-subterranean canal during the present eruption, but if its main vent near the principal eruptive conduit is still open, we can assume that with any renewed rise of the magma the lava will follow the same route. If, on the other hand, the breaches in the main pipe have been closed, the magma will reappear at the central crater until other subterranean routes are opened.

It is not possible to give a more explicit explanation of the eruption of Etna. The hypothesis of radial fractures which split the volcano at its base is not in harmony with the observed phenomena, and is contrary to the principles of the statics of liquids.

In this eruption it has been observed that the explosions were due to the detonation of explosive mixtures of volcanic gases—hydrogen, carbonic oxide, and methane—which are given off by the lava, and, when collected in subterranean cavities, form explosive mixtures with the oxygen of the air. The explosions were strongest in those parts of the fissures where deep chambers had formed in which the gases could collect, while towards the uncovered portions of the lava-canal there were milder explosions, with only small jets of lava. Later, when along this canal small cones were formed with corresponding explosion-chambers, the noises became intense. At the mouths of some of these small explosion-cones, there were often seen hissing darts of flame like those of powerful oxyhydrogen jets. These flames, due to the burning of the volcanic gases, have been observed at other volcanoes.

Various experiments were made during this important eruption. Of particular interest were the successful attempts to reduce, or even to stop for a short time, the explosions at some of the craters near their mouths by introducing carbon dioxide gas, which prevented the combustible gases from meeting with the oxygen of the air. In another experiment, nitrogen was blown through the liquid lava in order to carry away the gases given off, and to enable them to be collected without contamination by the air. This was carried out by means of a special apparatus, already described in the *Rendiconti della Reale Accademia dei Lincei*, vol. xxxi.,

[*Photo: G. Ponte.*

FIG. 2.—The north-east crater at the beginning of the eruption of May 1923.

1922, pp. 387-389. From the repeated trials made, it was definitely proved that the gases so collected are free from water. Thus the theory of the anhydrous nature of the magmatic gases, advanced by Albert Brun, receives fresh experimental confirmation.

on the cyclonic movements caused by convection currents in the hot air over the lava-flow.

In honour of the King and the Premier, the Accademia Gioenia di Catania has given the name Vittorio Emanuele III. to the new craters in the upper part of

[Photo: G. Ponte.

Fig. 3.—Explosion-craters, Vittorio Emanuele III.

Many observations were made of the temperature of the lava, and it was found that this varied in different parts of the flow owing to superficial cooling in contact with the air. At a temperature of from 670° to 690° the lava was still pliable, and could be easily bent and compressed. Some interesting observations were made the eruptive region, and has named those near the vent from which the lava issued Crateri Mussolini.

Many foreign vulcanologists came to see the eruption, and among them I had the pleasure of seeing Dr. G. Kemmerling, chief of the Vulcanological Service of the Dutch Indies.

Population and Unemployment.[1]

By Sir William H. Beveridge, K.C.B.

The impression that the civilised world is already threatened with over-population is very common to-day. Many, perhaps most, educated people are troubled by fear that the limits of population, probably in Europe and certainly in Great Britain, have been reached, and that a reduction in the rate of increase is an urgent necessity. Most, if they were asked to give reasons for their fear, would refer to one or both of two reasons: they would point to the enormous volume of unemployment in Britain; they would say that economic science, at least at Cambridge, had already pronounced its verdict. I propose to begin by raising some doubts as to the validity of each of these arguments.

The volume of unemployment in Britain is undoubtedly serious, and almost certainly unparalleled in past history. Those who see, as we now do, more than a million wage-earners whom our industry for years together is unable to absorb in productive employment may be excused if they draw the inference that there are too many wage-earners in the country. The inference, though natural, is unjustified. Unemployment in Britain can in any case prove nothing about the world as a whole. History shows that it does not prove over-population even in Britain.

During the last half of the nineteenth century, the industry of the United Kingdom was finding room for a rapidly increasing number of wage-earners with an admittedly rising standard of production and comfort. Through the whole of that period there was unemployment in the country. The percentage of trade unionists out of work never fell to zero; in no year since 1874 was it less than two; at more than one crisis it reached a height comparable if not equal to that which we have

[1] From the presidential address delivered to Section F (Economic Science and Statistics) of the British Association at Liverpool on September 17.

just experienced. During 1922 this percentage has averaged fifteen; but it averaged over eleven in 1879 and over ten in 1886. These figures are not on an identical basis, and are therefore not absolutely comparable. Taken for one year only, they understate the relatively greater seriousness of our recent experience, since the unemployment percentage was high through a large part of 1921 as well as in 1922, and still continues high. But the difference is one of degree rather than of kind. The peril of inferring over-population from unemployment is conclusively shown.

The experience of 1879 was up to then unparalleled; probably it was as much worse than anything previously recorded as the experience of 1922 appears worse than that of 1879. The experience of 1879, however, the record year of unemployment, heralded, not over-population and the downfall of British industry, but a period of expansion and prosperity which reached, if it did not pass, all previous records. "Real wages," which had risen thirty per cent. in the twenty years to 1880, rose even more rapidly in the next twenty years to 1900. Any one who in 1879, looking at the half or three-quarter million unemployed, had argued that the existing population of the United Kingdom (then about thirty-four millions) was all that the country could support without lowering its standards, would have been lamentably discredited at once. Ten years later he would have found a population nearly three millions more, enjoying a real income per head that was a fifth greater, with the unemployment percentage reduced to two. Ten years later still the population had grown further in size and in prosperity; those trades had grown most rapidly in which there had been and continued to be the largest percentages of unemployment.

The problems of unemployment and of over-population are distinct; they are two problems, not one. Severe unemployment has occurred in the past without over-population, as a function of the organisation and methods of industry, not of its size. On the other hand, it is very doubtful if excessive growth of population has ever shown itself or would naturally show itself by causing unemployment. A more probable effect would be pressure to work more than before in order to obtain the same comforts: a fall of real wages per hour, by increase either of hours or of prices.

The same dependence of unemployment on the organisation and methods of industry, rather than on its size, appears if we look, not backwards in time, but round us in space. It has been pointed out by Prof. Cannan that one of the few groups of economists who from our post-War sufferings can at least obtain the high intellectual satisfaction of saying "I told you so," is that which maintains that changes in the purchasing power of money are the most potent causes of the fluctuations in prosperity known as cycles of trade or booms and depressions. "In the pre-War period booms and depressions swept over the whole western world at once and left their causes obscure. In 1922 we have been treated to a sharp contrast between two groups of countries, one group having boom and full employment, the other depression and unemployment, the difference being quite clearly due to the first group having continued the process of currency inflation, the other group having dropped it." To bring this generalisation down to particular examples, we see in Central Europe a nation which assuredly should be suffering from over-population if any nation is; Germany, defeated in war, has been compressed within narrower limits, has lost its shipping and foreign investments, its outlets for emigration and trade, and now by high birth-rates is repairing with exceptional speed the human losses of the War. Germany may or may not be suffering from over-population. She certainly has not suffered from unemployment; she has had a boom stimulated by inflation of the currency. We see on the other hand Britain, victorious in war, with expanded territories and the world open to her, pursuing a different, no doubt a better, currency policy, and experiencing unexampled unemployment. To argue uncritically from unemployment to over-population is to ignore the elements of both problems.

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In regard to Europe as a whole we find no ground for Malthusian pessimism, no shadow of over-population before the War. Still less do we find them if we widen our view to embrace the world of white men. The fears expressed by Mr. Keynes in his book "Economic Consequences of Peace" seem not merely unnecessary but baseless; his specific statements are inconsistent with facts. Europe on the eve of war was not threatened with a falling standard of life because Nature's response to further increase in population was diminishing. It was not diminishing; it was increasing. Europe on the eve of war was not threatened with hunger by a rising real cost of corn; the real cost of corn was not rising; it was falling.

. . . .

For Europe and its races the underlying influences in economics were probably still favourable when the War began. But the war damage was great, and we are not in sight of its end. Man for his present troubles has to accuse neither the niggardliness of Nature nor his own instinct of reproduction, but other instincts as primitive and, in excess, as fatal to Utopian dreams. He has to find the remedy elsewhere than in birth control.

Let me add one word of warning before I finish. Such examination as I have been able to make of economic tendencies before the War yields no ground for alarm as to the immediate future of mankind, no justification for Malthusian panic. It has seemed important to emphasise this, so that false diagnosis should not lead to wrong remedies for the world's sickness to-day. But the last thing I wish is to over-emphasise points of disagreement with Mr. Keynes. The limits of disagreement are really narrow. The phrases that I have criticised are not essential to Mr. Keynes's main argument as to the consequences of the War and the peace. Whether Mr. Keynes is right or, as I think, too pessimistic as to economic tendencies before the War, he will, I am sure, be regarded as right in directing attention again to the importance of the problem of population. Nothing that I have said above discredits the fundamental principle of Malthus, reinforced as it can be by the teachings of modern science. The idea that mankind, while reducing indefinitely the risks to human life, can, without disaster, continue to exercise to the full a power of reproduction adapted to the perils of savage or pre-human days, can control death by art and leave

births to Nature, is biologically absurd. The rapid cumulative increase following on any practical application of this idea would within measurable time make civilisation impossible in this or any other planet.

In fact, this idea is no more a fundamental part of human thought than is the doctrine of *laissez faire* in economics, which has been its contemporary, alike in dominance and in decay. Sociology and history show that man has scarcely ever acted on this idea; at nearly all stages of his development he has, directly or indirectly, limited the number of his descendants. Vital statistics show that the European races, after a phase of headlong increase, are returning to restriction. The revolutionary fall of fertility among these races within the past fifty years, while it has some mysterious features, is due in the main to practices as deliberate as infanticide. The questions now facing us are how far the fall will go; whether it will bring about a stationary white population after or long before the white man's world is full; how the varying incidence of restriction among different social classes or creeds will affect the stock; how far the unequal adoption of birth control by different races will leave one race at the mercy of another's growing numbers, or drive it to armaments and perpetual aggression in self-defence.

To answer these questions is beyond my scope. The purpose of my paper is rather to give reasons for suspending judgment until we know more. The authority of economic science cannot be invoked for the intensification of these practices as a measure for to-day. Increased birth control is not required by anything in the condition of Europe before the War, and is irrelevant to our present troubles. But behind these troubles the problem of numbers waits—the last inexorable riddle for mankind. To multiply the people and not increase the joy is the most dismal end that can be set for human striving. If we desire another end than that, we should not burk discussion of the means. However the matter be judged, there is full time for inquiry, before fecundity destroys us, but inquiry and frank discussion there must be.

Two inquiries in particular it seems well to suggest at once. The first is an investigation into the potential agricultural resources of the world. There has been more than one elaborate examination of coal supplies; we have estimates of the total stock of coal down to various depths in Britain and Germany, in America, China, and elsewhere; we can form some impression of how long at given rates of consumption each of those stocks will last; we know that "exhaustion" is not an issue for this generation or many generations to come. There has been no corresponding study of agricultural resources; there is not material even for a guess at what proportion of the vast regions—in Canada, Siberia, South America, Africa, Australia—now used for no productive purpose, could be made productive; and what proportion of all the "productive" but ill-cultivated land could with varying degrees of trouble be fitted for corn and pasture. Without some estimate on such points, discussion of the problem of world population is mere groping in the dark. The inquiry itself is one that by an adequate combination of experts in geographic and economic science—not by a commission gathering opinions or an office gathering statistical returns—it should not be difficult to make.

The second is an investigation into the physical, psychological, and social effects of that restriction of fertility which has now become a leading feature of the problem. This also is a matter neither for one person —for its scope covers several sciences—nor for a commission; facts rather than opinions or prejudices are required.

If the question be asked, not what inquiries should be made but what action should now be taken, it is difficult to go beyond the trite generalities of reconstruction, of peace and trade abroad, of efficiency and education at home. The more completely we can restore the economic system under which our people grew, the sooner shall we absorb them again in productive labour. Unless we can make the world again a vast co-operative commonwealth of trade, we shall not find it spacious enough or rich enough to demand from Great Britain the special services by which alone it can sustain our teeming population. Even if the world becomes again large enough to hold us, we shall not keep our place in it with the ease of Victorian days; we dare no longer allow, on either side of the wage bargain, methods which waste machinery or brains or labour. Finally, if there be any question of numbers, if there be any risk that our people may grow too many, the last folly that we can afford is to lower their quality and go back in measures of health or education. Recoil from standards once reached is the gesture of a community touched by decay.

Obituary.

Mr. Frederick Chambers.

THE death is announced of Mr. Frederick Chambers, late Meteorological Reporter for Western India, at the age of seventy-seven years. Mr. Chambers was the younger brother of Charles Chambers, who went out from Kew Observatory in 1864 to take charge of the Colaba Observatory, Bombay. Frederick went out as assistant to his brother. In 1873 his paper, "The Diurnal Variation of the Wind and Barometric Pressure at Bombay," was published in the Phil. Trans. of the Royal Society, and another paper, "Mathematical Expression of Observations of Complex Periodical Phenomena; Planetary Influence on the Earth's Magnetism," written in collaboration with his brother, appeared in the Phil. Trans. in 1875. About this time Mr. Chambers was appointed Meteorological Reporter for Western India. A quotation from the first annual report which he printed is not without interest. It is explained that meteorological instruments had been sent out from England in 1852, "the duty of making the observations at those places being imposed on the senior medical officers"; the comment is made, "We would hope that from the zeal and energy of medical officers in charge of European hospitals and their love of science, the observations may be made by themselves and their establishments,

without entailing on the public any expense on this account."

The zeal and energy of the medical officers, and their love of science, however, seem not to have been equal to the occasion, for after vainly endeavouring, until the end of 1855, to carry out the orders they had received, without entailing expense on the public, it was arranged, at the direction of the Honourable Board, that two European soldiers should be told off at each station to undertake the duty of making meteorological observations on an allowance of 25 rupees per month for each observatory. The soldiers were sent to the Bombay Observatory early in 1856 for a preparatory course of training, on the successful completion of which they were furnished with certificates of competency to perform the work. Soon after this time the real work of meteorological registration may be said to have commenced, for, so far as the observers are concerned, the work from this time appears to have been carried on generally in a thorough and satisfactory manner. Under Mr. Chambers's administration the instruments were for the first time regularly compared with standards, and trustworthy data, such as made the Climatological Atlas of India possible, were collected.

Dr. Christian Hess.

One of the directors of the Farbenfabriken vorm. Friedr. Bayer und Co., in Leverkusen, Dr. Christian Hess, died on July 11 in Bonn, after a serious operation. He was born January 14, 1859, at Eisenach, studied chemistry first at Jena and then in Berlin, where he worked for his doctorate under A. W. v. Hofmann in 1881. After having been assistant chemist to Prof. Wichelhaus at the Institute of Chemical Technology, he went in 1883 to the newly founded weaving, dyeing, and finishing school in Crefeld, where he developed very great activity as a teacher and an expert adviser. At that time he invented his process for removing iron from water. The large number of coal-tar dyestuffs of a new character, which were discovered at that time, brought with them the necessity of using new methods for dyeing. This caused a lot of difficulties in the dyeworks, to meet which the dyemakers engaged colourists of good chemical training, able to introduce the new methods. One of the first of these was Dr. Hess, who was engaged by the Farbenfabriken in 1894.

Dr. Hess showed remarkable commercial ability, and after some time the whole of the sale of dyestuffs was entrusted to him; he was nominated a director in 1906. His knowledge of men and things enabled him to render many important and lasting services to the industrial side. His firm, his colleagues, his employees and the great number of men he helped with good advice, with sound reasoning and with hearty encouragement, when in difficulties, will much regret his premature death.

Prof. J. Violle.

The issue of the *Revue scientifique* for September 22 contains a notice of the death of Jules Violle, professor of physics at the Conservatoire des Arts et Métiers, which occurred at Fixin, near Dijon, on September 12. Violle was born in the same district on November 16, 1841. After obtaining his doctorate in 1870, he was in succession professor of physics at Grenoble, at Lyons, and at the École Normale. In 1897 he was elected a member of the Paris Academy of Sciences in succession to Fizeau. He was president of the French Physical Society, of the Society of Electricians and of the Committee of Inventions for National Defence. His earliest research was a determination of the mechanical equivalent of heat by means of the Foucault currents in a disc rotating in a magnetic field. His result, about 4 per cent. too high, was published in 1870. His work on the temperature of the sun appeared in 1877, and in 1884 he proposed as a standard of light, that radiated normally by a sq. cm. of molten platinum at its freezing-point. From 1886 to 1905 he published in conjunction with Vautier a number of memoirs on the speed of sound particularly in tubes. His "Cours de physique," which began to appear in 1883, was never completed.

We regret to record the death, on July 26, of Alexander Ellinger, professor of pharmacology in the University of Frankfort. Before the foundation of the latter university Ellinger held a similar chair at Königsberg. He was best known for his chemical work. Thus he showed that ornithine and lysine are decarboxylated by bacteria to putrescine and cadaverine respectively. He supplied the final touches to the determination of the constitution of tryptophane, and synthesised this amino-acid. Its transformation to kynurenic acid by the animal organism occupied much of his attention, and a few years ago he was able to elucidate the mechanism of this peculiar change, which apparently takes place via the keto-acid corresponding to tryptophane.

The Brooklyn Museum Quarterly of July includes an obituary notice of Prof. William Henry Goodyear, best known by his work entitled "The Grammar of the Lotus," who died in February last aged seventy-seven. The theory developed in this book was conceived during his studies of lotiform decorations in Cypriote art, and included a study of the lotus in the decorations on peat from early Egyptian times. In his work as an architect his discoveries of architectural refinements will prove most important. His published work is extensive and valuable, and is fully recorded in the sketch of his career by Mr. W. S. Conrow.

We regret to announce the following deaths:

Sir Halliday Croom, emeritus professor of midwifery at the University of Edinburgh and lately president of the Royal College of Surgeons, Edinburgh, on September 27, aged seventy-six.

Dr. P. Friedländer, professor of organic chemistry and of organic-chemical technology at the Darmstadt Technical College, aged sixty-six.

Dr. Herbert McLeod, F.R.S., honorary director of the Royal Society Catalogue of Scientific Papers, on October 1, aged eighty-two.

Current Topics and Events.

PROF. LYDE's leading article in last week's NATURE points to the need for a scientific basis for any programme aiming at the development of Empire resources which may result from the deliberations of the Imperial Economic Conference. A satisfactory organisation for effecting this purpose should embrace three main lines of work, namely, the exhibition of Empire raw materials, the technical examination of "new" or little-known products, and the systematic collection and dissemination of information relating to raw materials, their marketing and industrial use. An organisation originally designed for the purpose exists in the Imperial Institute. The Public Exhibition Galleries provide what is unobtainable elsewhere, namely, a permanent exhibition, under one roof, of the resources of all the countries of the Empire, so organised that a visitor desiring special information is, on inquiry, referred to the appropriate department of the Institute. These collections should be of great value to the business man, and their educational importance to the university student, no less than to the scholars who visit the Galleries in large numbers, conducted by the official guide, is obvious. Special lectures for the general public are also given by recognised authorities. The complement of the collections is the Scientific and Technical Department, the investigations of which—specially planned to meet the needs of the case—in conjunction with the assistance of the technical and commercial committees of the Institute, have served the economic development of the Empire to a degree unsuspected by the general public. The essential link in the scheme, namely, the collection and dissemination of technical and other information, and an organisation for dealing with the constantly growing stream of inquiries, exists in the Technical Information Bureau, which forms the intelligence department of the Institute and has proved of great practical service.

OUR famous medical contemporary, the *Lancet*, began its hundred and first year of publication on October 6, when a supplement was issued of nearly eighty pages, profusely illustrated by the portraits of many distinguished friends and some of the equally distinguished enemies of the paper. The text, modestly and humorously written, is a truly remarkable record of facts in medical highways and byeways during the past century. It is not too much to say that the present state of medical education and practice in England, its established efficiency and security and freedom from all grave abuses, is as much due to Thomas Wakley's *Lancet* as to anything else. Its scurrilities, venomous nick-names—"little eminent"—the rollicking old libels, semi-caricatures, "intercepted letters," and grandiloquent but downright abuse in plain English are now things past regret. Wakley's handling of them was perfectly in accord with his time; while his sense of right, his courage, and his devotion to a great cause would receive high admiration in our own. In the first ten years of his paper's existence there were six actions for libel, the aggregate sum of 8000*l*. being claimed for damages; the aggregate of 155*l*. 0*s*. 0½*d*. was awarded, the editor's costs being largely defrayed by public subscription. The design of the paper was to supply medical information which was available at that time to but few people, and to show that hospitals were not served, and that students were not trained, by persons selected for their merits. The libel actions arose out of the publication of supporting evidence, and ceased as reforms followed. Wakley's accusations of nepotism in hospital management and malpraxis in hospital practice gained public hearing in the Bransby Cooper case. His campaign against the Royal College of Surgeons of England, at first mismanaged, resulted in the appointment, in 1834, of Warburton's Parliamentary Committee of Inquiry into the state of the medical profession, and, later, in the Act constituting the General Council. Since then, lunacy, food adulteration and water-supply, workhouse administration, the advancement of Lister's views and of anæsthetic technique, and, indeed, every notable contribution by science to medicine, have in turn provided the *Lancet*, under Wakley guidance, with fields for great constructive work. The Centenary Supplement is a document of absorbing interest, personal and professional, a becoming memorial to great Englishmen.

MR. W. J. U. WOOLCOCK, the General Manager of the Association of British Chemical Manufacturers, described to representatives of various technical journals on Monday last the progress which has been made with the preparation of the Chemical Section of the British Empire Exhibition to be held at Wembley next year. The Chemical Section, which is being organised by the Association, and occupies nearly 40,000 square feet in the Palace of Industry, will be built in such a way as to form a Hall within the Palace. About 100,000*l*. will be spent in presenting to the public a picture of the present state of British chemical industry. No important firm in the industry will be unrepresented, and the whole of the individual exhibits, numbering about one hundred, will, by reason of their position and character, combine to form a magnificent illustration of the industry. Considerable attention has been paid to the lay-out and to the decoration of the Chemical Hall. There will, for example, be about two hundred yards of a specially painted frieze illustrating various operations in chemical manufacture; and as the majority of the stands are being designed by the same architect, the treatment of each stand is likely, while maintaining the individuality of the occupier, to present a very pleasing picture of the Hall as a whole. In the centre of the Chemical Hall there is to be illustrated the progress which has been made in pure chemistry during the past twenty or thirty years, with the view of showing that the stream of scientific invention in this country is still flowing steadily onwards. The Scientific Section is being organised by a Committee consisting of representatives of the following bodies: The Chemical Society, the Institute of Chemistry, the Societies of Chemical

Industry and of Dyers and Colourists, the Pharmaceutical Society, and the Institutions of Petroleum Technologists and Chemical Engineers. The Committee is working in close co-operation with the Royal Society. Sir Herbert Jackson acts as the representative of the Royal Society on the Committee and Mr. Woolcock in a similar capacity on the Royal Society Committee. In order that both the general public and scientific persons may have a record of the exhibit, it is proposed to publish a number of pamphlets specially written for the purpose dealing in popular language with the various classes of exhibits in the Scientific Section. In addition to this it is proposed to publish in more technical language a work, which will not only explain the scientific exhibits, but will put on record in a very complete form the state of our knowledge in chemical matters at the date of the Exhibition. It is anticipated that there will be a very large demand for this valuable record, each chapter of which will be contributed by an authority in the subjects dealt with, and that it is likely to find a place on the bookshelf of every scientific worker.

IN the hope of checking the rabbit pest in Australia, it is proposed by the Commonwealth to make large advances, not exceeding 250,000*l.*, to cover the cost of supplying settlers with wire netting on easy terms. Every State would get a fair proportion of the netting. The second reading of the bill has been carried in the House of Representatives. The money is to come out of the Consolidated Revenue Fund, and its amount indicates the continued seriousness of the situation. In the course of the discussion in the House it was mentioned that thousands of acres, in South Australia in particular, had depreciated to half their value owing to the rabbit pest, and it was stated that whereas in 1893 there were 60,000,000 sheep in New South Wales, the number was now down to 32,000,000 because of the rabbits. The calamitous interference with the balance of Nature involves a vicious circle, for the hope of permanent relief is increase in the agricultural population so that concerted and widespread elimination may be organised, but this increase is checked because the rabbits tend to make the settlers' work economically hopeless. Trapping and poisoning, netting and inoculation, have been tried with persistence, but the prolific multiplication of the rabbit continues to defeat man's efforts. Attention is being re-directed to the Rodier method, which has proved effective in areas of considerable size. Mr. W. Rodier suggested that doe-rabbits should be killed in as large numbers as possible, but no bucks. In the areas experimented with, the result was that the bucks killed the helpless young and also that the does were persecuted to death by the demands of the bucks. In other words, the polyandry became so intense that the females perished in large numbers. The method has experimental facts in its favour, and it is applicable to other pests such as rats and sparrows. A practical difficulty is in distinguishing the sexes before the act of killing.

WE regret to learn that on the afternoon of September 20, a violent explosion followed by fire occurred in the Dynamometer Laboratory of the Bureau of Standards, Washington, D.C. One man was killed instantly, three others injured so seriously that they died during the night, and four others seriously burned or cut. The heroism of the survivors of the staff in rescuing the injured from the furiously burning wreckage and in shutting off the electric circuits and the ammonia valves, minimised the loss of life and property. The explosion occurred in the altitude chamber which is used in testing the performance of aircraft engines under the conditions of low pressure and temperature obtaining at high altitudes. At the time of the accident the room was being used in investigating the performance of an automobile engine, at temperatures corresponding to winter operation, using various grades of gasoline. The work was intended to determine the possible increase in gasoline production per barrel of crude oil, with the accompanying conservation of oil resources, by the use of gasoline of lower volatility. The explosion was due to the ignition of an explosive mixture in the chamber. The men who were killed are: Logan L. Lauer, Urban J. Cook, Stephen N. Lee, and Joesph Kendig; while those injured are: Henry K. Cummings, Frank E. Richardson, Roger Birdsell, George W. Elliott, C. N. Smith, and R. F. Kohr. Most of these men were college graduates with experience and skill in research work, and a grave blow to science and engineering must be added to the human loss to their families and colleagues. Thus grows the long list of those who have given their lives for the increase of human knowledge and welfare.

THE first number of an important and interesting publication, *The British Journal of Experimental Biology* (Edinburgh: Oliver and Boyd. Quarterly, 12*s.* 6*d.* net; annual subscription, 40*s.* net) has recently been issued from the Animal Breeding Research Department of the University of Edinburgh, with Dr. F. A. E. Crew as editor in chief. The experimental method has become so indispensable in biological research that it is perhaps remarkable that no special journal has hitherto been devoted in Great Britain to its results, though America and Germany have long possessed such media of publication. The British journal, however, covers a wider field than any existing publication, as is sufficiently evident from the fact that the contributions to the first number are drawn from such diverse institutions as the Animal Breeding Research Department, Edinburgh, the Zoological Departments of the Universities of Edinburgh and Oxford, the Physiological Department of the University of Oxford, and the Natural History Department of the British Museum. Of late years there has been a strong tendency towards over-specialisation among working biologists and the new journal should do good service in promoting the unification of biological science. We are glad to note that it is the intention of the editors to publish regular reviews of recent progress in different fields of research; the critical summary on that very modern branch of biological science known as tissue culture, by H. M. Carleton, which appears in the present number, shows

how valuable a feature such reviews are likely to be. The journal is very attractive in appearance; both letter-press and illustrations are excellent and the price is moderate. We wish it all success, and especially a large body of subscribers.

"The Natural History of Wicken Fen," Part I. (Cambridge: Bowes and Bowes), which is to continue appearing until the volume is completed, under the general editorship of Prof. J. Stanley Gardiner and Mr. A. G. Tansley, is a very desirable record of public-spirited action by entomologists and botanists, supported by the National Trust for Places of Historic Interest or National Beauty. The Trust now holds for the benefit of the nation 521 acres, which include the greater part of the old undisturbed fenland in Wicken Sedge Fen, St. Edmund's Fen, and Burwell Fen, and has obtained leases of other areas. Mr. A. H. Evans, the secretary of the local committee formed in Cambridge in 1914 to further the purchase and preservation of the fenland, states that the Trust is able to look forward with confidence to the early purchase of a further 60 or 70 acres if funds are available. Mr. Evans reports that "very little more remains to be done in this direction," an eminently satisfactory state of affairs for which we have to thank many generous donors, but notably the late Mr. G. H. Verrall, of Newmarket, an ardent entomologist who realised the value of the undisturbed fenland to the student of insect life. The volume now commenced is to place on record the history and the biology of the fenland, and the present part contains Mr. Evans's history of the fens, with especial reference to Wicken Fen, and of their drainage and its effect upon the fauna and flora, together with an account of the butterflies and moths of Cambridgeshire by W. Farren, which is substantially the same as that appearing in the British Association Handbook for 1904. The local committee has wisely decided not to leave the fen "to Nature," which, as the secretary points out, would mean eventually the formation of a tangled impenetrable thicket of the tall coarse sedge (*Cladium Mariscus*) shaded by alien trees, but to see that excessive growth is thinned out and the waterways kept so that the winter floods may profit the ground. The characteristic fen country has never been an untouched wilderness, but so far back as its history is known the sedge crop has regularly been cut, being once of considerable value.

Sir E. Sharpey Schafer is to deliver the first Victor Horsley Memorial Lecture at the Royal Society of Medicine on Thursday, October 25, at 5 o'clock, taking as his subject "The Relations between Surgery and Physiology."

The sixth annual Streatfeild Memorial Lecture will be delivered in the Chemical Lecture Theatre of the Finsbury Technical College, Leonard Street, E.C.2, at 4 o'clock on Thursday, October 25, by Mr. E. M. Hawkins. The subject will be "Analytical Chemistry," and admission will be free.

The eighth annual meeting of the Optical Society of America will be held at Cleveland, Ohio, in the Case School of Applied Science, on October 25-27. The address of the retiring president, Dr. L. T. Troland, will be on "The Optics of the Nervous System." Prof. A. A. Michelson will read, by invitation, a paper on "The Limit of Accuracy in Optical Measurement," and Mr. F. A. Whiting, director of the Cleveland Museum of Art, will address the Society on "The Optical Problems of an Art Museum." A number of papers on general optics, vision, colorimetry, photometry, spectroscopy and instruments will also be presented.

The programmes for the meetings of the Royal Microscopical Society during the coming winter session have been issued, and the Society is to be congratulated on the excellent series of papers and communications which will be submitted for discussion. The section dealing with the industrial applications of the microscope has a specially attractive list, and in addition to the large number of exhibits, the practical demonstrations shown will be a leading feature at each meeting. Arrangements have been made for communications and discussions dealing with coal, petrology, metallurgy, textiles (cotton and linen), paper, bee-keeping, and poultry-keeping. A further attraction of the meetings of the Industrial Applications Section will be a series of lecture demonstrations, which will embody a practical course of instruction in the manipulation of the microscope. These will be given by Mr. J. E. Barnard, and a detailed syllabus of the same will be forwarded on application to the secretary to the Society, 20 Hanover Square, W.1.

The latest news of Mr. K. Rasmussen's expedition to Arctic Canada has been brought to Europe by Mr. Birket-Smith, who has returned to Copenhagen. According to the *Times*, Mr. Rasmussen had reached Pelly Bay, near the Magnetic Pole, at the end of April on his way to Alaska and Siberia in his endeavour to trace the route of Eskimo migrations. Mr. P. Freuchen is following the Eskimo track via Baffin Land, Lancaster Sound and Ellesmere Land to Thule in north-western Greenland. Mr. Birket-Smith completed his task of visiting the inland Eskimo tribes in Melville Peninsula and Rae Isthmus.

The *Times* publishes an account of the travels in Spitsbergen last August of the Merton College expedition. The original project of exploring North-East Land had, as was fully expected, to be abandoned. It is far beyond the scope of a summer visit. The vessel carrying the party was able to penetrate Hinlopen Strait from the north, land a sledging party on the western shore and reach Ulve Bay on the south coast of North-East Land. On the pack closing in, a retreat was made northward along the strait and a brief visit was paid to the north coast of North-East Land. Pack ice prevented progress beyond Cape Brunn and the vessel was forced to return. After a visit to Klaas Billen Bay, where the sledging party was picked up at Camp Bruce, the expedition returned to Norway. On the west side of North Cape was found a canvas tent bag which has been identified as a relic of the German Expedition of 1912 and doubtless belonged to Lieut. Schroeder Stranz, who lost his life in an attempt to sledge over insecure sea-ice.

Bibliography of meteorological literature, No. 4, has recently been issued by the Royal Meteorological Society, having been prepared with the collaboration of the Meteorological Office. It deals with all meteorological publications and articles on meteorology recently received, giving the titles and references where the literature is to be found. The division of the subject-matter under specified heads enables a would-be student to determine the helpful line of reading which he is desirous of prosecuting, without loss of time. Divisions are given for the several meteorological elements, such as atmospheric pressure, temperature, solar radiation, aqueous vapour and cloud, rain, wind, storms, and weather forecasting, with other allied subjects.

We have received a copy of the Report of the Proceedings of the Natural History Society of Bishop Stortford College for 1922. It is the first report published by the Society, and contains a list of the plants found in the district during the years 1920–1922, an account of the more interesting Lepidoptera occurring during 1922, and a note on the birds of the year. A list of the more important additions to the school museum during the year and a general account of the activities of the Society, especially in the maintenance of vivaria and aquaria, are added. The successful attempt to induce the viper to breed in captivity is a notable achievement. The Society can be congratulated on having got together a nucleus of enthusiastic and active workers, and we hope the publication of this report will stimulate its members to increased and more sustained work on the fauna and flora of the district.

We have received from Messrs. Watson and Sons, Bulletin 29 S. on diathermy apparatus. The introductory remarks are reprinted from an article by Dr. E. P. Cumberbatch, who has made important contributions to this subject. This foreword explains clearly the methods which are necessary for the production of sustained oscillations of the right frequency for the purposes in view, and also gives some account of the surgical and medical uses to which the diathermy currents can be put. The early designs of the instrument have been much improved so as to allow a large output of these currents, and the spark gap, which has often proved the weakest feature of the instruments, is now run in an atmosphere of coal gas; if this is not available, petrol or acetone may be used. The bulletin is illustrated by various parts of these machines and by a great variety of electrodes for the various cavities of the body.

The Cambridge University Press announces the forthcoming publication of "The Archæology of the Cambridge Region," by C. Fox, which will form a topographical study of the bronze, early iron, Roman, and Anglo-Saxon ages, with an introductory note on the neolithic age. The object of the work is to provide a basis for future detailed study, period by period, of the archæological remains of the district and of the many problems connected with them.

Our Astronomical Column.

Photographic Magnitudes of Satellites of Jupiter.—Mr. Seth B. Nicholson has made a careful study by photography of the magnitudes of the eighth and ninth satellites of Jupiter. Reduced to mean opposition they are 17·6 mag. and 18·6 mag. respectively. Assuming albedoes similar to that of Jupiter III (Ganymede), the diameters are about 30 miles and 20 miles.

Perturbations by the Method of Quadratures.—In 1908, Dr. P. H. Cowell introduced the method of following the perturbed motion of a planet or comet by calculating the forces acting in three directions mutually at right angles, and so obtaining the second differences of the x, y, z co-ordinates of the body; being given the initial values, the successive ones are then formed by addition of the differences.

Mr. B. V. Noumeroff has lately improved the method in a paper in vol. ii. of Publications de l'Observatoire Astrophysique de Russie. Mr. Commendantoff contributes a paper to *Astr. Nach.*, No. 5249, explaining the method and applying it to form positions of Ceres from 1913 to the present time. The Nautical Almanac has discontinued its ephemeris of the four bright asteroids, and since then regular ephemerides have not been available.

The point of the method is the use of new co-ordinates formed from x, y, z by multiplying them by a factor so chosen that the differences between the second and the sixth disappear, which greatly simplifies the calculation. The first approximation, using Jupiter perturbations only, at 40-day intervals, represents the place of Ceres for ten years with no error exceeding 15 seconds of time, which is sufficient for a finding ephemeris; it is further shown how the calculated co-ordinates may be improved when later observations are available. The method appears to be worthy of careful study.

Studies in Stellar Masses.—Many recent studies in this field have been mentioned in this column. Dr. E. Hertzsprung contributes another to Bulletin No. 43, Astron. Instit. of Netherlands. He classifies 14 pairs of known orbit elements and parallax; they include the interferometer results for Capella and the eclipsing variable β Aurigæ; the mass of each component is deduced and the logarithm of the mass plotted against the quantity $m+5 \log p$, where m and p are the apparent magnitude and parallax respectively. The graph connecting the two is nearly linear, showing a close correlation between mass and absolute magnitude, a result reached by other investigators. An expression using first and second powers of log mass is preferred, as it gives a better fit; it is noted that the formula fits well for the sun.

A table is given enabling the parallax to be deduced when the magnitudes and orbit elements are known. The star ζ Orionis is discussed. This star has a motion in position angle of 1° in 9 years, but the arc described is too short for finding an orbit. Jackson found the hypothetical parallax 0·016″ assuming a mass double that of the sun. The parallax found from the new formula is 0·0038″, which is regarded as more trustworthy. It agrees well with other estimates of the distance of the Orion group.

Dr. Hertzsprung appeals to parallax observers to pay special attention to stars the orbit elements of which are either known or are likely to be determinable before long.

Research Items.

FIRE-MAKING ON THE GOLD COAST.—In the September issue of *Man*, Mr. A. W. Cardinall describes the use of the flint and steel in fire-making in the northern territories of the Gold Coast. The tinder used is cotton from the kapok, and is carried about in all sorts of receptacles—cotton or leathern bags, or more rarely in the more primitive way in the hollowed-out seeds of the fan-palm. Only one case of sacred fire is recorded where the fire is maintained, more or less permanently, outside the chief's compound: there is no special rite observed in lighting it, but no one may take fire from it. The fuel used is dried cow-dung, and in the rains the fire is allowed to go out. Sacrifices are made to it, some of the blood and bones of the victims being placed in a pot laid on the top of the fire. Only the chief and one other man, not identified, are allowed to eat the flesh of the sacrifice.

THE OCCURRENCE OF THE LIZARD IN MAORI CARVINGS.—In the *New Zealand Journal of Science and Technology*, March, 1923, Mr. Elsdon Best of the Dominion Museum notes that one of the remarkable features of Maori carved work is its lack of natural forms, particularly of the local flora. Some animals are delineated, but none so faithfully resembling the original as the lizard. The type known as Manaia seems to have been confused with the lizard, possibly because this is one meaning of the word, but the Manaia form is really the old Indian motif of Vishnu flanked by two Garudas, the powers of Good and Evil. Mr. Best thinks it probable that the introduction of the lizard or crocodile into carved designs originated in the western Pacific, possibly in Indonesia. He gives numerous examples of superstitions connected with lizards, one being that the Maori is said to believe that the spirits of his ancestors revisit the earth in the form of lizards. This may to some extent account for its introduction into Maori art.

HAWAIIAN LEGENDS.—A collection of Hawaiian legends by William Hyde Rice forms Bulletin No. 3 of the Bernice Pauahi Bishop Museum at Honolulu. The narrator is the son of missionaries who arrived in Hawaii in 1840, and he has been familiar with the Hawaiian language since his earliest childhood. He has been a member of the House of Representatives, and a Senator, and was Governor of Kauai under Queen Liliuokalani until after the revolution of 1898. The legends are fairy tales pure and simple with no underlying mythological meaning. They were told by the bards or story-tellers, either itinerant or attached to the courts of the chiefs, where alone the stories were to be heard. Some had historical foundations now forgotten, others were efforts of the imagination. Some of these legends Mr. Rice remembers having heard as a boy, and places mentioned in the stories were pointed out to him. Among the legends are those of Pele the fire-goddess, the Rainbow Princess, and Ulukaa the rolling island. Another tells of the Menehune, mythical dwarfs only two or three feet high, who were tremendously strong but ugly of face. They were credited with all sorts of magical powers and perfect skill, but would only work one night on any construction. If not completed it was left undone. Other stories are those of Kawelo the hero of Kauai, of Paakaa and his son Ku-a-paakaa, of Kana the strong, of the beautiful Kaili-lau-o-kekoa and of Makuakaumana, the man who was swallowed by a big fish, and several others. A glossary of Hawaiian terms with notes is given as an appendix, and a portrait of Mr. Rice forms a frontispiece. The work is a valuable addition to the lighter legendary lore of Hawaii.

CERAMICS AND MINERALOGY IN JAPAN.—Examples of the thoroughness with which Japanese scholars bring the most modern developments of research to bear upon economic problems, and at the same time welcome economic problems as enlarging scientific knowledge, are to be found in Vol. 1, No. 3 of the third series of Science Reports of the Tôhoku Imperial University. The outcome in this case is that mineralogists will learn much from experiments undertaken for the ceramic industry, since the scientific results that are obtained in the course of the investigations are recorded as matters of fundamental interest. Shinjo Satoh, for example, in his work on fire-clays, observes (p. 200) that kaolinite loses its combined water between 400° and 600° C.; that an internal change takes place between 900° and 1000° C.; and that between 1200° and 1300° C. a further internal change occurs from the recombination of free silica and aluminium silicate that became dissociated at a lower temperature. The gradual corrosion and ultimate fusion of quartz grains in a magma formed from lead glass and clay pulverised together is, among many other instructive matters, illustrated by microscopic sections (p. 195 and Pl. 11). Kunikatso Seto (p. 219) gives a number of new analyses of felspars, mostly from classical localities, and S. Kōzu and M. Suzuki (p. 233), following Des Cloizeaux, have studied the influence of temperature on the optic axial angle of sanidine. The locality and chemical composition of the specimens are, we think, not stated. The considerable increase in the optic axial angle recorded for high temperatures by Des Cloizeaux is found to be due to an abrupt change at about 900° C. X-rays have been utilised, and the Laue diagrams obtained show that this change is not accompanied by alteration of the space-lattice.

PHYSIOLOGICAL CLASSIFICATION OF OATS.—Investigations relative to the yielding and other properties of oat varieties under different conditions of soil and climate are described by M. G. Jones in Bull. C. No. 3, of the Welsh Plant Breeding Station. Trials were carried out with autumn and spring sown varieties from 1920–2, aspects of their economic and agricultural behaviour being considered. The different varieties are compared with one another in detail, with special regard to such points as the relation between the yield of straw and various other factors, for example, the time taken to reach maturity, the date of emergence of the panicle, average height of the plants and the yield of grain. The tillering capacity of the same varieties in different years was also considered. The information gained from the experiments indicates the possibility eventually of classifying varieties of oats on a physiological basis in such a way as to afford practical guidance to the farmer in the selection of his seed corn.

EFFECTS OF RADIUM RADIATIONS ON TISSUES.—The July issue of the quarterly journal *Radium* contains a number of papers dealing with the effects of the radiations from radium upon the tissues. These papers have for the most part been published in American Medical Journals and indicate the extent to which radium is used in many conditions other than malignant disease. A paper by Bailey and Bagg deals with the effects of irradiation on foetal development in the lower animals. On the basis of this work, they consider that if radiation is applied in late pregnancy, though it may not produce gross abnormalities at birth, it may hinder the growth and development of the child in later life. MacNeal and Willis describe a case of squamous-cell carcinoma

forming on the hand of a radiologist after too frequent exposures to tubes of radium which he handled during the course of clinical work. A new device for the application of radium to the tonsils is described by Stewart, a previous article in this issue upon the treatment of neoplasms of the tonsil by Quick showing that good results are obtained by methods which ensure a thorough irradiation of the affected parts.

CRETACEOUS OVERFOLDING IN THE ALPINE REGION.—A detailed review of the results of recent observations on the Alpine overfolds, and particularly of L. Kober's work on the deeply penetrating "Tauernfenster" in 1921, is given by A. Tornquist of Graz in the *Geologische Rundschau*, vol. 14, pp. 110-145 (1923). The title, "Intrakretazische und alttertiäre Tektonik der östlichen Zentralalpen," shows how the movements that have produced successive overfolded sheets have been traced back into the Cretaceous period, the most striking evidence being the unconformable deposition of the Gosau beds upon the earliest overfolded series. The notice of Kober's "Bau und Entstehung der Alpen" in NATURE, vol. 112, p. 322, gave some hint of these conclusions.

METEOROLOGY IN THE EAST INDIAN SEAS.—The Meteorological Chart of the East Indian Seas for September, recently issued by the Meteorological Office, is of considerable interest. Winds and ocean currents are dealt with in detail, together with the normal atmospheric pressure and temperature of air and sea, as well as other matter of importance to the navigator. The chart comprises the Red Sea and covers the area from the Cape of Good Hope to the China Sea and Western Australia. It is well shown how under normal conditions the ocean current responds to the prevailing wind. The winds are under the direct influence of the several areas of high and low barometer, and in any position on the chart the seaman can interpret the changes he is experiencing, in normal circumstances, and can estimate how soon he may expect a change of conditions. The observations used extend over a period of about sixty years. On the back of the chart ocean currents are discussed for the track between Honolulu and Fiji. Current-roses are used on a system analogous to the wind-roses on the face of the chart, a system somewhat open to question, and for any extended alteration in this direction expert knowledge is desirable, if possible equal to that given to the general system, hitherto used, of showing ocean currents. A comparison is given of temperature in fixed and in portable screens on board ship. Probably the position of the screen must be left chiefly to the commander of a ship, with cautious suggestions. The usual form of screen used at sea, supposing the single louvre screen to be still in use, has to be screened itself, as single louvres are not effective.

RADIOACTIVITY AND SOLAR RADIATIONS.—It has been asserted that radioactivity is independent of all known physical agents; but M. A. Nodon, in the *Comptes rendus* of the Paris Academy of Sciences of June 11, describes additional experiments, which seem to confirm his previously expressed view that the process is greatly accelerated by very penetrating radiations from the sun. These radiations are able to penetrate a thin sheet of lead, the absorption being greater the higher the atomic number of the screen employed. The action is more marked during periods of solar activity.

TEMPERATURE OF THE CROOKES DARK SPACE IN GLOW DISCHARGE.—Observations on the glow discharge have recently been made in the Physikalisch-Technischen Reichsanstalt at Charlottenburg by Herr A. Günther-Schulze. He measured the energy delivered to the cathode, and there converted into heat; and found the ratio that it bore to the total energy delivered to the cathode and the dark space; this amounted to 72 per cent. in argon at 1·83 mm. pressure, 39 per cent. in hydrogen at 2·37 mm., and as much as 73·4 per cent. in nitrogen at 3·53 mm. If the free path of the atoms corresponds to room temperature, or the dark space is cool, this ratio is about 20 per cent. The natural conclusion is that the dark space is heated by the collisions taking place in it between the positive ions and the gas molecules; and a calculation of the probable temperature, in the case of one of the experiments with nitrogen, leads to the figure 720° C. The electrical energy expended in the dark space appears to be sufficient to account for this rise of temperature. The length of free path at this temperature is such that a considerable proportion of the ions pass through the dark space without colliding with a molecule, and the number of average free paths between the boundary of the dark space and the cathode must be small. All this agrees with the fact that, when the velocity of canal-rays is measured, a marked proportion have the velocity corresponding to the total cathode fall. The free path of the electrons is four times as great as that of the positive ions, so that most of them cross the dark space without collision, and begin to produce ions when they reach the negative glow, the maximum number per electron being equal to cathode fall divided by ionisation voltage. It follows that the ratio of the electronic current to the ionic current in the dark space is about 1 : 10.

FREE PATH OF SLOW ELECTRONS IN MONATOMIC GASES.—Using an incandescent cathode, a cylindrical grid surrounding it, and a concentric cylindrical anode at a voltage very slightly higher than the grid, it is found that the form of the characteristic curve showing the relation between anode current and grid voltage is strongly influenced, in the case of argon, by the abnormally long free path of very slow electrons through this gas. Minkowski and Sponer in a paper dated March 27, published in the *Zeitschrift für Physik*, give the curves obtained with argon, krypton, xenon, neon, and helium. For the first three gases there is a sudden rise in the current curve at zero voltage, followed by a sudden drop; with neon and helium, there is a less marked sudden rise, followed by a more gradual rise; in all these cases, however, and also in the case of mercury vapour, the shape of the curve near zero volts is to be explained by the fact that the free path of slow electrons is abnormally long. In the case of the inert gases, certain sharp upward bends in the succeeding portions of the curves are interpreted as being due to the fact that the electrons have reached the velocity required either to excite the atoms or to ionise them; and, making the proper corrections, the voltages agree quite well with those which direct measurement shows are needed to produce these effects. When the electrons strike the atoms in inelastic collision their velocities are reduced, their free paths are increased, and, as a result, the current becomes greater. With argon, a number of these sudden jumps of current are observed, corresponding to two different excitation voltages, to the ionisation voltage and to twice one of the exciting voltages or the sum of the two; this implies that the velocity of the electrons, at one of the last-mentioned points, is such that it can collide with an atom exciting it, and retain sufficient energy to excite another atom.

Report of the British Broadcasting Committee.

THE Committee appointed by the Postmaster-General on April 24 last to consider the present position of broadcasting in Great Britain and make recommendations for the future, made its report to him on August 23; the document (Cmd. 1951, H.M. Stationery Office, price 9*d*. net) was issued to the public on October 1.

By the terms of reference, the Committee had to consider: (*a*) Broadcasting in all its aspects; (*b*) the contracts and licences which have been or may be granted; (*c*) the action which should be taken upon the determination of the existing licence of the Broadcasting Company; (*d*) uses to which broadcasting may be put; and (*e*) the restrictions which may need to be placed upon its user or development.

The Report, which is admirably drawn up, has been signed by all the members of the Committee; reservations are, however, made on a few points by three of them. There is every evidence that very careful consideration has been given by the Committee to the many matters associated with the present-day broadcasting problem; and certain important recommendations are made in its Report. The task of the Committee has been one of peculiar difficulty, owing to the existence of a licence from the Post Office to the British Broadcasting Company for the operation of a scheme which, while still having some eighteen months to run, has in certain respects broken down in practice. The Committee has wisely decided to disregard to a great extent this complication and has dealt with the situation practically as though the Government had a free hand.

In view of the possibility that all large communities may eventually demand this inexpensive service, and that Imperial and international broadcasting services may eventually be established, the Committee considers that "the control of such a potential power over public opinion and the life of the nation ought to remain with the State, and that the operation of so important a national service ought not to be allowed to become an unrestricted commercial monopoly." It is further pointed out that a technical reason for such control also exists: all wireless telegraphy and telephony has to be conducted within a limited group of "wave-lengths," and every new wireless station takes up a certain "waveband," which no other sending station within a certain radius should be permitted to use. These "wavebands" must, the Committee considers, be regarded as a valuable form of public property, and the right to use them for any particular purpose should be authorised only after careful consideration and in such a way that the public interest may at all times be fully safeguarded.

The Committee recognises that broadcasting is still in its infancy and that new applications of it are likely to arise from time to time in many directions. It is of opinion that, if conducted on proper and sound lines, broadcasting will be of great educative value, both directly and indirectly, and it has been much impressed with the widespread enthusiasm which broadcasting has aroused. The great interest in wireless telegraphy and telephony promoted by broadcasting in almost every class of society cannot but tend, the Committee foresees, to produce beneficial results, stimulating as it does experiment and research. "The listener," the Report says, "may perhaps become an experimenter; the experimenter may possibly become an inventor."

The Report deals briefly with the events which led to the appointment of the Committee and gives an outline of the present scheme, its merits and defects being set out. The Committee places on record the fact that the evidence placed before it "demonstrates that the British Broadcasting Company have shown enterprise and ability of a high order in carrying out their undertaking and have done much valuable pioneer work in the face of many difficulties." The Report also comments upon the objections which have been raised by certain manufacturers and dealers to the present scheme. The Committee expresses the following opinions thereon. It agrees with the view that it is wrong in principle to attempt to control the manufacture and importation of wireless apparatus by means of licences issued by the Postmaster-General. As regards the remaining objections, it agrees that the scheme gives the British Broadcasting Company unusual powers; the Committee, however, has had no proof that the Company has made any improper use of its position. The scheme for levying a contribution on apparatus from the manufacturers was, the Committee points out, imposed by the Government as a condition of the broadcasting licence which the manufacturers desired.

The first of the recommendations contained in the Report relates to a matter affecting the Controlling Authority. The Committee considers that the questions involved in broadcasting are so complex, and the decisions to be taken so various and require so much technical and other consideration, that a Standing Committee (unpaid) should be set up by Statute to assist the Postmaster-General in the administration—technical, operative and general—of broadcasting. It is recommended that this Committee, for which the name "Broadcasting Board" is suggested, should be composed of an independent chairman, preferably a specially qualified member of the House of Commons, nominated by the Postmaster-General, and twelve members—of these two should be specially qualified persons nominated by the Postmaster-General, and the remainder should be drawn from certain interests or bodies named in the Report. In connexion with this recommendation, the Committee thinks that broadcasting may eventually become "so great a national responsibility as to demand the creation of a small paid body of experts, to whom (always subject to the Postmaster-General) its control should be entrusted."

Sir Henry Norman, a member of the Committee, makes an important reservation in relation to the composition of the proposed Board. In his opinion "a heterogeneous Board of thirteen members, giving voluntary service, eleven of them not necessarily with special knowledge of the subject and possibly without technical knowledge at all, presided over by a member of the House of Commons, who would, of course, be chosen from the political party in power, and whose tenure of office would be subject to political exigencies, would be inefficient, would carry little authority, and its proceedings would therefore be for the most part futile." Sir Henry is in favour of the appointment of a highly-qualified and well-paid Broadcast Control Board, say, of three members; that is to say, he would prefer that immediate effect should be given to that part of the Committee's Report which recommends the creation at a future date of a small paid body of experts for the control of broadcasting.

The arguments for and against the operation of the broadcasting services by the State are set out in the Report. The Committee considers that the objections to State operation of the service outweigh the advantages; at the same time, it is of opinion that no licence issued by the Postmaster-General

should preclude the Government from using its own wireless stations for the broadcasting of such information as may be deemed desirable, subject, of course, to the ordinary broadcast programmes being interfered with as little as possible. Mr. C. Trevelyan, a member of the Committee, expresses regret that his colleagues were unable to agree to the operation of broadcasting by the Post Office. He is of opinion that a situation may easily arise in which this may be the only satisfactory possibility and gives reasons for the views he holds.

In dealing with the means of securing widespread reception with the cheaper types of receiving sets, the Committee points out that most of the existing difficulties might be avoided or reduced by the provision of a considerable number of transmitting stations of lower power than those already existing. The possibility of employing relay stations and linking them up by Post Office telephone trunk lines to main centres is also touched upon. Developments in these directions depend upon certain technical factors, and the outlay for thus dealing with the whole country would be large, both as regards the wireless stations and the land lines. Such a scheme, the Committee points out, would enable great numbers of persons to use "crystal" receivers, and it is likely the revenue from licences would be correspondingly increased. So far as future developments are concerned, the Committee thinks that the greatest latitude should be left to the Controlling Authority, and is a matter in which it would be unwise for the Committee itself to attempt to define the policy which should be adopted. A recommendation is, however, made that the licence issued to the British Broadcasting Company, which has the requisite organisation and technical and other experience, should, subject to certain variations in its terms indicated in a later part of the Report, be continued.

The alternative methods of meeting the cost of broadcasting and the several considerations that come into play are comprehensively dealt with in the Report. Having considered the evidence placed before it on the subject, the Committee has come to the conclusion that, in order to cover the cost of running its eight stations and to pay a dividend on its capital at the rate of 7½ per cent. per annum, the British Broadcasting Company requires a revenue of 160,000*l.* a year—or, if allowance is to be made for future developments and improvements, not less than 250,000*l.* a year. Of the methods of raising revenue proposed, the Committee entirely rejects the one containing a proposal that the cost of broadcasting should be met wholly or partially out of public funds. With regard to the suggestion made to it that a substantial contribution towards the cost of the service should be obtained by means of a system of licensing the manufacture and sale of wireless apparatus, the Committee says that the proposal merits careful consideration, but it is unable to recommend its adoption.

In dealing with the existing method of raising revenue by means of fees collected on licences issued to owners of receiving apparatus, the Committee has had to consider the objection which has been raised in principle to a Government Department handing over public revenue collected by it to a private individual.

The Committee is of opinion that the arguments advanced against the adoption of this method of providing funds for broadcasting are based on an incorrect conception of the nature of the transaction and recommends the continuance of the present arrangement whereby revenue is collected by means of licences for receiving sets, a part of which is handed over to the British Broadcasting Company. The aim of the Post Office should, the Committee thinks, be to obtain sufficient revenue from licence fees (*a*) to cover administrative expenses in connexion therewith with a safe margin, and (*b*) to provide the necessary contribution to the cost of the broadcast programme. In the event of a considerable increase in the number of licences, the resulting surplus should, it is suggested, be devoted (i.) to reducing the licence fee; or (ii.) to improve the service; or (iii.) to both these purposes. As the Post Office authorities estimate that the cost in connexion with the issue of licences is unlikely to exceed 2*s.* 6*d.* per year per licence, an amount of 7*s.* 6*d.* per licence would be available, if required, to meet the cost of all broadcasting services. The total number of licences issued up to the present is about 170,000, and there are about 30,000 applications for experimental licences held in suspense, making a total of about 200,000. It is impossible, of course, to say what is the number of unlicensed stations; it is stated in the Report that the number is probably nearer 200,000 than 100,000. The Committee is of opinion that, if a high standard of programmes is maintained, it is not unlikely that within a few years the number of broadcast listeners may rise to a million or more. In view of the possibility of a very considerable increase in the number of licences, the Committee suggests that under any new arrangement a sliding scale should be adopted in relation to the proportion of the licence fees to be paid to the operating company or companies.

The Committee recommends that the marking of apparatus should be abandoned and one uniform licence introduced for broadcast reception and another for experimental work. It is further recommended that the broadcast licence should be placed on sale at Post Offices and issued on payment of the fee without any formalities or questions. It is pointed out that the Post Office would thereby be relieved of the difficult and somewhat invidious duty of determining whether applicants are genuine experimenters or not. With a view, however, of safeguarding neighbouring installations from interference, it is recommended that a clause should be inserted in the new licence in the following terms:—"The station shall not be used in such a manner as to cause interference with the working of other stations. In particular, back-coupling must not be used to such an extent as to energise any neighbouring aerial." Disregard of this condition should, it is suggested, render a licence liable to summary cancellation, and, further, that provision should be made for levying a penalty in cases where a licensee can be proved to have repeatedly caused serious interference. It is also suggested that for purposes of meeting cases where persons set up and use unlicensed receiving stations, statutory powers should be obtained similar to those already possessed by the Customs and Excise Department in connexion with the licences they control, so as to place the Postmaster-General in a position (*a*) to call upon suspected persons to fill in a form of declaration showing whether they are liable to a licence fee or not; and (*b*) to accept a compromise fine in the case of a minor default as an alternative to prosecution.

Having regard to the existing agreement between the Post Office and the British Broadcasting Company, the Committee recognises that it would not be possible for the Postmaster-General to introduce any change in the present scheme whereby the rights of the Company would be adversely affected, except as a matter of negotiation between the parties thereto. It is of opinion that the immediate adoption of its

recommendations as a whole would entail certain adverse effects on the British Broadcasting Company and its constituent members. In consequence, the Committee suggests that if its recommendations are carried out forthwith, the proportion of the licence fee to be paid to the Company should be increased from 5*s.* to 7*s.* 6*d.* per licence, subject to the application of the sliding scale already referred to; this 7*s.* 6*d.* rate to take effect from November 1, 1922, when broadcast receiving licences were introduced. It is further recommended that the period of the Company's revised licence should be extended for two years beyond the original term, *i.e.* to January 1, 1927. It is proposed that in return for these concessions the Company, on its part, shall agree (*a*) to the immediate application of the scheme recommended; (*b*) to the revision of its articles of association, in order to provide (1) for dealers and retailers of wireless apparatus to obtain at least one 1*l.* share in the Company, (2) for members of the public to take up shares, if and when fresh issue of capital is made, and (3) for securing adequate representation on the Board by the new membership; and (*c*) to the abolition of the deposit of 50*l.* now required from members.

Mr. J. C. W. Reith (the General Manager of the British Broadcasting Company), a member of the Committee, makes a reservation as to the conditions proposed in relation to the issue of uniform licences and as to the general application of the scheme recommended; he is of opinion that under the proposed scheme the interests of the British manufacturers will not be sufficiently safeguarded.

On the technical side, the Committee makes certain important recommendations as to wave-lengths and the hours during which broadcasting services may be provided. It considers that arrangements should be made for the greatest possible extension of the existing broadcast band of wave-lengths (350 to 425 metres), preferably by the allocation of a band from 300 to 500 metres, excluding 440 to 460 metres, and that all possible steps should be taken to protect the band allocated to broadcasting from interference by other services. The Committee further suggests that the present restrictions on the hours of broadcasting should be removed, so that additional broadcasting facilities might be provided. These changes, it is considered, can be readily introduced without detriment to the other interests which have to be considered.

In relation to the broadcasting programmes, the Committee states that the British Broadcasting Company has achieved a large measure of success in gauging the public taste and providing programmes, and suggests that there should be a gradual extension of broadcasting of news, under proper safeguards; it is also urged that more latitude should be given to the broadcasting of special events without regard to hours. Finally, the Committee places on record its conviction that the Postmaster-General should remain the final arbiter when any question is raised as to what kind of matter may or may not be broadcasted.

Contemporaneously with the issue to the public of the Report of the Broadcasting Committee, a statement was sent to the Press by the Post Office; therein it is announced that the Postmaster-General feels that it is not possible for the scheme recommended by the Committee to be brought fully into operation immediately, but, with the view of the continuance of the broadcasting services, he has agreed with the Company to the introduction of a constructor's licence at a fee of 15*s.* for a limited period—the licensee must in such cases give an undertaking that, in constructing his apparatus, he will not knowingly use parts manufactured elsewhere than in Great Britain or Northern Ireland. Further, with the view of meeting the case of the 200,000 persons who are supposed to be in possession of unlicensed receiving apparatus, it is proposed to issue a special interim licence at a fee of 15*s.* also, covering present apparatus, whether home-made or purchased and irrespective of its place of manufacture, provided that this licence is taken out before October 15. In such cases no charge will be made for past usage, nor will proceedings be instituted for the failure to comply with the law. The issue of the constructor's and the interim licences will be continued until December 31, 1924, and, subject to sanction by the House of Commons, the Postmaster-General agrees to pay 12*s.* 6*d.* and 7*s.* 6*d.* out of the 15*s.* and 10*s.* broadcasting licences respectively to the British Broadcasting Company. The decision of the Postmaster-General to raise the licence fee to the home-constructor has come as a real disappointment to a very large number of them: to many of this class of listener the increase of the fee from 10*s.* to 15*s.* makes all the difference whether they can possess a licensed station of their own or do without one altogether.

An agreement has also been come to between the Post Office and the British Broadcasting Company for the modification of the articles of association of the Company on the lines recommended by the Committee. The licence now held by the Company will be prolonged, on suitable conditions, to the end of 1926; provided that the Company gives a satisfactory service and is willing to erect additional stations, should the Postmaster-General require this to be done, it is given what is virtually a monopoly during the unexpired period of the original agreement. However, the rights of the Postmaster-General are reserved, in certain circumstances, from and after December 31, 1924; thereafter not only may he, in appropriate cases, license other organisations, but he may also give them an adequate share of the revenue arising from new licences. The Postmaster-General may further (without regard to geographical area) license other services without withdrawing any part of the licence fees to which the Company may be entitled.

It is announced also that the Postmaster-General proposes at an early date to appoint an Advisory Board, as recommended by the Committee, to assist him in all important questions relating to broadcasting. Presumably this Board will be a statutory body: whatever may be the sources from which its membership is drawn, it is to be hoped that every care will be taken to avoid the creation of the inefficient type of Board so strongly condemned, and justly so, by Sir Henry Norman in the special paragraph contributed to the Report by him.

The action taken by the Postmaster-General on the Report of the Broadcasting Committee brings to a close the deadlock which has now for some months existed between the Post Office and the British Broadcasting Company. It is somewhat unfortunate that the restoration of peace between the parties to the original agreement has been purchased at the expense of a class, the home-constructors, who are deserving of greater consideration than they are about to receive. It is not at all improbable that the course of events may cause both the Postmaster-General and the British Broadcasting Company to regret that the recommendations of the Broadcasting Committee in relation to the introduction of one uniform broadcast licence have not been at once put into force.

Pioneers of Metallurgy.[1]

The relationship of scientifically trained experts to the actual work of the world is much closer than at first sight would appear. The introduction of bronze and iron into the daily life of our ancestors marked the initiation of epochs of an importance to civilisation only secondary to the advent of fire. Metals were prepared from their ores, and worked into beautiful and useful forms, thousands of years before science, as now understood, existed. So far as we know, the necessary knowledge and skill must have been arrived at by a process of trial and error; or, in other words, by the method of experiment and observation. There have been, from time to time, revivals during which the arts and crafts made great steps forward. These steps must necessarily have resulted from the revival in individual workers of the dormant interest and belief in experiment and observation, no doubt stimulated by the generally increased activity of thought in the times in which they lived. The material progress of the past has invariably been due to observation of the actual phenomena leading to experiment on, and observation of, the effect of changed conditions on these phenomena; observation followed by thought, leading to experiment, followed in turn by further thought.

While the vast majority of our fellow-men have had neither the desire nor the capacity for experiment and observation, it is impossible to avoid the conclusion that there have been from the start of the human race individuals of this type to whom civilisation on its material side has owed practically everything. Of the equally important element of thought which must follow observations if these are to lead to practical achievements much might be said. While thought must be critical in the broadest sense, it must also be constructive. In the true pioneer it must, if need be, override the purely negative function of criticism, for without courage and enthusiasm in facing the unknown no real pioneering work can be done. This type of constructive thought in its higher development is one of the rarest of intellectual qualities.

The pioneers among the early workers in metals must, like their more modern successors, have possessed some strains of this great quality, this instinct which makes for progress. Here also we find that there has been absolute continuity in the evolution of workers in metals from our prehistoric ancestors down to the designers of this laboratory, which in itself is a visible expression of the latest thought and practice in the production and manipulation of metals. One of the laboratories here is named after Henry Cort, in memory of his epoch-making work on the manufacture of malleable iron in Great Britain one hundred and forty years ago. This may be gladly accepted as an admirable illustration of the point that the qualities which make for progress are deep down in the very nature of the individual pioneer, who, in many cases, owes little or nothing to the systematic knowledge of science. In Cort's case he knew the primary object of the free exposure of molten cast-iron rich in carbon to a moderately oxidising atmosphere in which the carbon was burned away, but it is improbable that he had any theoretical idea as to how the fibrous texture of the resulting iron was produced. By trial and error he definitely ascertained the conditions of atmosphere, of temperature, and of working at each stage which would attain the desired result, and this knowledge he was able to translate into a workable process on a large manufacturing scale.

While an exact knowledge of scientific laws and methods is a tool which must be placed in the hands of the future workers in, and directors of, the metal industries, the material on which this tool is to be employed must be their own close and personal observation of facts and phenomena, and time must be unsparingly devoted to the acquirement of this habit until it becomes instinctive and automatic. Let us not forget that, in spite of our wide knowledge of scientific laws and phenomena, the skilled craftsman may still be our model in this type of observation.

[1] Abstract of an address delivered by Sir George Beilby on September 11 at the opening of the new Metallurgical Department of the University of Manchester.

American Genetical and Botanical Research.

The great amount of valuable research being accomplished in biology, genetics, and botany by the investigators of the Carnegie Institution of Washington is shown by the reports from the Departments of Genetics and Botany in the Year-Book for 1922 of the Institution. Reports are included not only of the experimental work at the Station for Experimental Evolution near New York, the Desert Botanical Laboratory at Tucson, Arizona, and the Coastal Laboratory at Carmel, California, but also from men holding chairs in various American universities, and from travel experiments in regions so far afield as South Africa and Australia. Only a few of the many lines of research of which this Year-Book contains reports of progress can even be mentioned in a short review.

We may mention Prof. W. E. Castle's continued studies on inheritance in mice, rats, and rabbits, in which the linkage relations between groups of characters are being worked out on a basis similar to the Drosophila experiments; and the further investigations of Prof. T. H. Morgan and his collaborators on the constitution of the germ-plasm in that little fly. Prof. C. A. Kofoid reports the discovery of amœbæ in connexion with such diseases as arthritis deformans (in bone marrow) and Hodgkin's disease (in lymph glands), and has also investigated various intestinal parasites. Mr. Albert Mann continues a monographic study of North American diatoms.

The work under the direction of Dr. C. B. Davenport includes many diverse fields of activity in genetics, eugenics, and animal behaviour. Co-operative breeding with mice and dogs; the study by Dr. Banta of intersexes and eyeless variations in parthenogenetic Cladocera; the continued experiments of Dr. Riddle on the metabolism of sex and other problems in pigeons; the investigations of Messrs. Blakeslee, Belling, and others on variations and chromosome relations in Datura, some of which parallel conditions discovered in Œnothera a decade ago; pedigrees of aristogenic and cacogenic families—these are but a few of the activities of this laboratory.

In botany, the report of Dr. D. T. MacDougal from the Desert and Coastal Laboratories is mainly concerned with physiological and ecological problems. The continued investigations of Dr. H. A. Spoehr and others on photosynthesis and other processes in the leaf have established a quantitative relation between photosynthesis and respiration. Dr. MacDougal continues the study of various problems of hydration and permeability in the plant cell, including the use

of a type of artificial cell. The dendrograph is also applied further in the study of the growth of trees and minute changes in the volume of the trunk.

The ecological work includes a study by Dr. Forrest Shreve of the factors influencing the altitudinal distribution of vegetation in Arizona, various observations by Dr. W. S. Cooper on the strand vegetation of the Californian coast, and on the endemic conifers of the Monterey peninsula. Dr. W. A. Cannon reports an atmometer experiment to test the evaporating power of the air in the Karroo and other parts of South Africa, and a study of the transpiring power of various Karroo plants, including species of Aloe, Gasteria, Cotyledon, and Protea. A similar series of observations on Welwitschia near Swakopmund shows that its transpiring power is very low. Full reports of many of these lines of research are either in preparation or will be published later. R. R. G.

The Mechanics of a Cyclone.[1]

A NOTEWORTHY attack is made by Dr. V. H. Ryd, in the paper referred to below, on the problem of the circulation of the air in a cyclone, the source of the energy necessary for its maintenance, and the disposal of the rising air. The cyclone considered is necessarily "ideal," with circular isobars, the pressure at any distance from the centre being determined by an arbitrary formula which gives good results for the body of the cyclone but causes a discontinuity at the boundary.

The first part of the paper, entitled "Preliminaries," leads to a series of fundamental differential equations which cannot be integrated, and in the second part a graphical method of solution is developed, by which the air-paths appropriate to the pressure distribution are constructed. This method is next applied to the more important case in which a uniform pressure gradient is superposed on the original circular isobars. The results are shown both as actual paths of air particles and as a synchronous representation of actual wind such as we see in a daily weather chart. In both cases the presentation appears to be in good agreement with Nature. From the air-paths so constructed it is easy to compute the variation of the surface area occupied by any given mass of air, and consequently the regions of rising and falling air. This is done for the surface, in Fig. 33, which is reproduced here (Fig. 1). The figures represent the percentage value by which the area changes in an hour, the broken lines referring to contractions (*i.e.* rising air), and the full lines to dilatations. The region of falling air in the north-west quadrant is of great interest and receives an important verification, with which the author was apparently not acquainted, in a chart showing the distribution of weather with reference to the centre of a depression which crossed England in November 1915 (A. E. M. Geddes in Q.J.R. Meteor. Soc., 43, 1917, p. 15).

The third part of the paper applies the results so obtained to the construction of a picture of the mechanism of travelling cyclones, supported by an actual numerical example. The ordinary temperature distribution results at great heights in a system of open, nearly parallel isobars corresponding with winds of great velocity at the cirrus level; this is termed the stationary system, and from the nature of its origin it extends with decreasing intensity nearly to ground level. Hence a travelling cyclone can be divided into four parts, namely, the ground stratum; the lower stratum of the free atmosphere in which the velocity of the wind arising from the stationary system is less than the speed of the cyclone; the central part of the cyclone, in which these two are equal; and the higher stratum, in which the velocity of the wind from the stationary system is the greater. The resulting pressure distributions, wind velocities, and vertical motions in these layers are studied, and combined in a description of the circulation of the air.

The conclusion is that the air which is thrust up in the portion of the cyclone with negative coefficients cannot escape until it reaches the highest stratum referred to above; in this stratum it is carried forward out of the system. The same conclusion applies to the descending air, which is sucked from the higher stratum to the ground level. Hence the "stationary system" provides the energy of the cyclone, and the author considers that in most cases

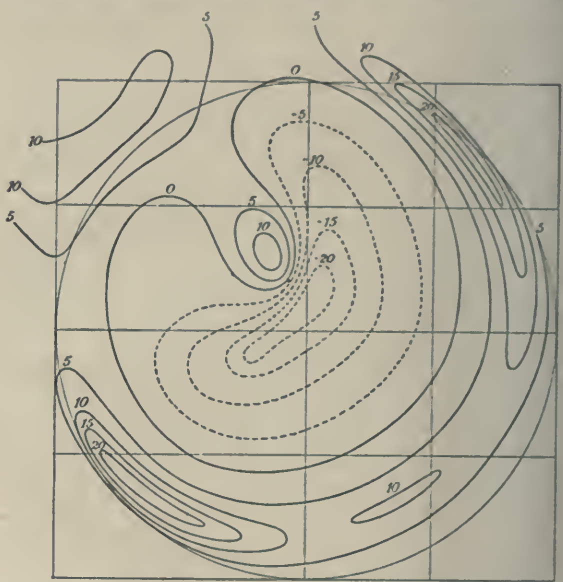

FIG. 1.—Variations of areas in a travelling depression.

the decay of an Atlantic cyclone is due to the dying out or disturbance of the stationary pressure field—a conclusion which requires further elucidation. In the last chapter attention is briefly directed to the agreement of these theoretical results with actual observations of the direction and speed of cyclones and the vertical and horizontal distribution of temperature, including the existence of a "cold front," which is thus shown to be a consequence, and not a cause, of the formation of a cyclone.

The paper is highly mathematical in treatment; this is, of course, necessary in a scientific account of new work, but it is unfortunate as being likely to deter the reader without a high mathematical equipment, although actually much of it can be read without mathematics. In view of the great interest at present taken in the "polar front" theory of cyclones and the importance of this vindication of the older view, it is to be hoped that the author will shortly present us with a more popular account, including more illustrations from Nature. It would have been better to have avoided attaching two different meanings to the symbol R, even though no confusion is caused thereby.

[1] Publikationer fra det Danske Meteorologiske Institut. Meddelelser Nr. 5: Meteorological Problems. 1: Travelling Cyclones. By V. H. Ryd. Pp. iv+124. (Kjøbenhavn: G. E. C. Gad, 1923.)

University and Educational Intelligence.

ABERDEEN.—The following assistants have been appointed: Anatomy, Mr. A. Lyall; forestry, Mr. E. V. Laing; mathematics, Mr. J. T. Lawrence; natural philosophy, Mr. H. D. Griffith; pathology, Mr. J. F. Davidson; physiology, Mr. J. Fiddes; surgery, Mr. W. Anderson.

CAMBRIDGE.—Of the additional annual grant of 30,000*l.* from the University Grants Committee, announced by the Vice-Chancellor in his annual address to the University, a sum of 4000*l.* annually from the total is ear-marked for the next ten years for the Women's Colleges.

ST. ANDREWS.—The induction of Prof. John Read to the chair of chemistry in the United College, and of Prof. Adam Patrick to the chair of medicine in the University, took place in the Hall of the University Library, St. Andrews, on Friday, October 5, at 4 P.M.

SPEAKING at a prize-distribution ceremony at the Maharajah of Kasimbazar's Polytechnic Institute, the new Vice-Chancellor of the University of Calcutta blessed Capt. Petavel's scheme (described in NATURE of August 26, 1922, p. 298) for establishing in Bengal co-operative educational colonies in which pupils would spend a considerable part of their time in remunerative employment on farms and in workshops. "Boys following the school and college courses as they are now, resemble," he remarked, "a flock of sheep rushing over a precipice,"—referring to the notorious overcrowding of the occupations for which alone those courses afford a suitable preparation. The scheme, however, notwithstanding its endorsement by the former Vice-Chancellor and many other Calcutta notables, still hangs fire, for want, apparently, of the funds necessary for making a start.

THE foundation stone of the first of the permanent buildings of the University of Western Australia was laid on September 1 by the Premier of the State, Sir James Mitchell. This building, which is being erected for the natural science lecture rooms and laboratories, is placed on rising ground overlooking Melville Water on the Swan River. The southern aspect of the building and its general design will give every facility for microscope work. It is proposed to proceed next with the transfer of the departments of chemistry, physics, and agriculture before removing the arts faculty and the administrative sections from the present temporary buildings in the centre of Perth city. The engineering school is already on the permanent site, having been in 1914 in the Crawley Mansion House on the transfer of the estate to the University by the Government of Western Australia.

PROGRESS in home economics education during the years 1920-22 is described in Bulletin No. 6 of 1923 of the United States Bureau of Education. A general demand for retrenchment in school expenditure led to proposals in many parts of the country for eliminating home economics as well as music, art, industrial arts, and agriculture from school curricula, but a reaction speedily ensued accompanied by a marked stimulation of local interest in the teaching of these subjects. Meanwhile, the campaign for economy had improved the teaching of such subjects as cookery through necessitating the use of simpler and less expensive methods and extreme care in regard to the quality of the resulting products. One of the most admirable modifications of home economics courses was the devotion of increased time and attention to training young women in child care and welfare. This training has been linked with the food courses in high schools through individual pupils being made responsible in the later stages of their work for the nutritional condition of some younger child. The food courses have themselves been markedly changed, cooking processes receiving less, and nutrition and dietetics greater emphasis than formerly.

RECENT awards of Industrial Bursaries and Overseas Science Research Scholarships by the Royal Commission for the Exhibition of 1851 are as follows. The names of the nominating institutions are in brackets. *Industrial Bursaries:* J. M. Todd (University of Edinburgh), W. McCartney (Heriot-Watt College, Edinburgh), G. B. Hamilton and D. Murray (University of Glasgow), G. G. Forrest (University of St. Andrews), T. Etheridge (University of Birmingham), A. G. Oates (University of Bristol), F. Allen (University of Leeds), W. B. Noddings and E. R. Knight (University of Liverpool), G. Lindley (University of Sheffield), F. F. Ridley (University of Durham: Armstrong College), J. S. Wilson (University College, Nottingham), J. F. Smith, J. M. Radcliffe, and W. A. P. Fisher (University of Cambridge), P. C. England (University of London: King's College), W. E. J. Budgen (University of London: East London College), A. Taffel (University of London: University College), G. A. Bonnyman (Imperial College of Science and Technology), J. R. Rowlands (University College of North Wales, Bangor), A. R. Brown (University College of South Wales and Monmouthshire, Cardiff), O. G. Evans (University College of Swansea), A. Goffey, R. E. L. Tricker, and C. R. Smith (University of Manchester). *Science Research Scholarships:* J. F. Lehmann, Physics (University of Alberta), I. R. McHaffie, Physical Chemistry (University of Manitoba), W. L. Webster, Physics (University of Toronto), R. W. E. B. Harman, Physical Chemistry (University of New Zealand), L. H. Martin, Physics (University of Melbourne), F. Lions, Organic Chemistry (University of Sydney).

Societies and Academies.

PARIS.

Academy of Sciences, September 17.—M. Joseph Boussinesq in the chair.—The president announced the death of M. J. Violle.—P. **Villard**: The true colour of clouds. It is generally admitted that the true colour of clouds is white, and that the colour effects observed are due to the coloured rays of the sun at sunrise and sunset. From the results of twenty years' observations the author believes that this is not always the case and that clouds may possess a colour of their own, not necessarily white, although illuminated with pure white light. Variations of colour have been noted during the disappearance and re-formation of light cumulus clouds.—P. **Sergesco**: The distribution of the characteristic values of the nuclei of Marty $N(x, y) = A(x)K(x, y)$.—Antoine **Zygmund**: The Riemann theory of trigonometrical series.—Georges J. **Rémoundos**: A property of elimination and algebroid functions.—O. M. **Tino**: The passage from the theory of the fundamental Fredholm functions to that of the fundamental Schmidt functions.—Serge **Bernstein**: The mathematical demonstration of Mendel's law of heredity.—A. **Petot**: A characteristic difference between the modes of action of front and back brakes. It is shown that there is a fundamental difference between

the action of front and back braking on a motor-car. The latter arrests only the motion of translation of the car; in the former the brake also affects the car's movement of rotation round the vertical. —L. J. **Simon** and M. **Frèrejacque**: The action of dimethyl sulphate on salicylic acid, methyl salicylate, and methoxysalicylic acid. Sulphonation and methylation. In the absence of water, methyl sulphate and salicylic react, giving three substances, $C_6H_3(OH)(CO_2CH_3)SO_3H$, $C_6H_3(OH)(CO_2CH_3)SO_3CH_3$, and $C_6H_3(OCH_3)(CO_2CH_3)SO_3H$. The trimethyl sulphonated derivative is not produced.—Ch. **Courtot** and A. **Dondelinger**: Some new secondary bases of the indene series.—Paul **Dumanois**: A method of air-drying. A scheme for preventing the moisture in air reaching absolute alcohol or petrol stored in bulk. —F. **Vincens**: The aspergillomycosis of bees.— R. **Herpin**: Ethology and development of *Nereis caudata*.

SYDNEY.

Royal Society of New South Wales, August 1.— Mr. R. H. Cambage, president, in the chair.—S. **Dodd**: Cancer of the ear of sheep: a contribution to the knowledge of chronic irritation as a secondary factor in the causation of cancer in the lower animals. Cancer of the ear is rather common in sheep in Australia. Ears from 47 sheep so affected were examined microscopically: 32 were found to be definitely epitheliomatous; 9 showed a condition of chronic inflammation only, and 6 were in a precancerous stage. An affected sheep received alive was kept under observation; five months later the middle cervical gland showed signs of enlargement. Six months after receipt the sheep was killed and the autopsy showed practically the whole of the ear to be carcinomatous. The facts presented support the view that a chronic irritation, naturally occurring, may lead to cancer in the lower animals.—L. S. **Cash** and C. E. **Fawsitt**: The estimation of cineol in essential oils by the Cocking process. The method consists in mixing the oil with *o*-cresol in certain fixed proportions and finding the freezing point of the mixture. The method is more easily carried out than any of the other methods usually employed for estimating cineol. The results are at least as accurate as those obtained in other ways and the accuracy can be increased by taking into consideration the density of the oil.—H. J. **Hynes**: Investigations by the late C. O. Hamblin into the Helminthosporium disease of wheat. Pathogenicity tests indicated that the strain of Helminthosporium isolated from Marshall's No. 3 wheat at Cowra in November 1920 is a true parasite of the wheat plant, capable of causing a "Foot-Rot" condition and also lesions on the leaves. Seed from diseased plants when sown gave rise to healthy plants. The "Foot-Rot" condition was observed at Cowra in 1921 on 150 different wheat varieties. Spores of Helminthosporium were found on Slav rye, skinless barley, *Hordeum murinum*, *Bromus inermis*, *B. sterilis*, and spear grass.

Official Publications Received.

Mitteilungen der Naturforschenden Gesellschaft in Bern. Aus dem Jahre 1920. Pp. lx+179. Aus dem Jahre 1921. Pp. xlvi+320+12 Tafeln. Aus dem Jahre 1922. Pp. lxiv+171. (Bern: K. J. Wyss Erben.)

University of California Publications in American Archæology and Ethnology. Vol. 18, No. 9: A Study of Bows and Arrows. By Saxton T. Pope. Pp. 329-414+plates 45-64. (Berkeley: University of California Press.)

The North of Scotland College of Agriculture. Calendar, Session 1923-24. Pp. viii+128. (Aberdeen.)

The North of Scotland College of Agriculture: County Extension Department. Report on County Extension Work, 1922-23. Pp. 50. (Aberdeen.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-Verbaux des Réunions, Vol. 31: Rapport Atlantique 1[illegible] (Travaux du Comité du Plateau Continental Atlantique) (Atlantic Slope Committee). Publié avec l'aide de Dr. Ed. Le Danois. Pp. 46+1[illegible] planches. (Copenhague: A. F. Høst et Fils.)

Smithsonian Miscellaneous Collections. Vol. 76, No. 2: History of Electric Light. By Henry Schroeder. (Publication 2717.) Pp. xiii[illegible] Vol. 76, No. 3: On the Fossil Crinoid Family Catillocrinidæ. By Frank Springer. (Publication 2718.) Pp. 41+5 plates. Vol. 76, No. 4: Report on Co-operative Educational and Research Work carried on by the Smithsonian Institution and its Branches. (Publication 2719.) Pp. [illegible] (Washington: Smithsonian Institution.)

Proceedings of the Aristotelian Society. New Series, Vol. 23: Containing the Papers read before the Society during the Forty-fourth Session, 1922-1923. Pp. ii+289. (London: Williams and Norgate.) 25s. net.

Diary of Societies.

MONDAY, OCTOBER 15.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Necrosis.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Extraordinary General Meeting.

TUESDAY, OCTOBER 16.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. G. Marshall: The Back Page of a Newspaper.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. E. Newberry and others: Discussion on The Origin of Cultivated Plants.

WEDNESDAY, OCTOBER 17.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Discussion on a paper by Sir Napier Shaw and Capt. D. Brunt: Towards a Basis of Meteorological Theory—Thirty-nine Articles of Condition for the Middle Atmosphere.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—W. F. Charles: Peculiarities in the Development of the Ant's Foot.—M. T. Denne: A New Variable Light Screen for Use with the Microscope.—Prof. Ekendranath Ghosh: Monocystides from the Earthworms of Calcutta.

THURSDAY, OCTOBER 18.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.— Squadron Leader R. M. Hill: The Manœuvres of Inverted Flight.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. F. S. Boas: Some Aspects of the Departmental Report on English.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. A. Russell: Presidential Inaugural Address.

CHEMICAL SOCIETY, at 8.—R. G. W. Norrish: Studies of Electrovalency. Part III. The Catalytic Activation of Molecules and the Reaction of Ethylene and Bromine.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall), at 8.—Dr. Marie Stopes: Medical Contradictions and Mistakes in Evidence in her Recent Case (Presidential Address).

FRIDAY, OCTOBER 19.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hernial Formations of Developmental Origin which occur along the Alimentary and Respiratory Tracts.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Sir John Dewrance: Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Pereira: In a Kinema Studio.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—F. W. Dye: The Gas Boiler (or Circulator) and its Application.

PUBLIC LECTURES.

SATURDAY, OCTOBER 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Capt. W. H. Date: Wireless Telephony—a Popular Exposition.

UNIVERSITY COLLEGE, LONDON, at 5.—Miss I. C. Ward: The Application of Phonetics to the Curing of Speech Defects.

TUESDAY, OCTOBER 16.

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. A. V. Hill: The Present Tendencies and Future Compass of Physiological Science.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on October 17, 18, and 19.)

WEDNESDAY, OCTOBER 17.

UNIVERSITY COLLEGE, LONDON, at 3.—Prof. E. G. Gardner: Problems of the *Inferno* (Barlow Lectures). (Succeeding Lectures on October 24, 31; November 7, 14, and 21.)

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—A. Greenwood: Cancer and the British Empire Cancer Campaign.

KING'S COLLEGE, LONDON, at 5.30.—Prof. A. Dendy: The Biological Foundations of Society. (Succeeding Lectures on October 24, 31; November 7, 14, 21, 28; December 5 and 12.)

THURSDAY, OCTOBER 18.

KING'S COLLEGE, LONDON, at 5.30.—Prof. J. A. K. Thomson: The Function of Scholarship.

SATURDAY, OCTOBER 20.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Tutankhamen and his Times.

NATURE

SATURDAY, OCTOBER 20, 1923.

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Scientific Papers and Books.

"Of making many books there is no end; and much study is a weariness of the flesh."

ONE of the problems which scientific investigators have to face is that of the great mass of literature with which they are supposed to make themselves familiar before they proceed along the road in which their interests lie. It is almost impossible in these days to keep in touch with everything published, even in a single department of science, by all the scientific societies and institutions of the world; and the result is that the announcement of an interesting observation or experiment is frequently followed by a claim for priority from another worker in the same field. Creative work of the first order is of course very rarely anticipated in this way, but determinations of properties, measurements of values, observations of structures, records of particular effects, and so on, are often duplicated and sometimes lead to discussions into which unworthy imputations are introduced.

Such publications as the International Catalogue of Scientific Literature and the Royal Society Catalogue are useful as guidance to what has been published on various subjects or by different workers, and several scientific societies publish collections of abstracts periodically, while the excellent Subject Index to Periodicals issued by the Library Association provides a means of ready reference to the titles of many papers worth attention. These and similar aids cannot be neglected by investigators engaged in original scientific work unless they are indifferent to what has been done, or is being done, by others in the same field. It is said that a government official who had been largely responsible for securing a grant for the International Catalogue of Scientific Literature once asked a distinguished man of science whether the Catalogue was very useful, and was astonished at the reply: "I do not know, because I have never used it." Few people engaged in research are, however, so original that they can afford to take this risk; for, like wise inventors, they realise that unless they know what has already been produced they may waste much valuable time in doing something for which no claim for originality can afterwards be substantiated.

The numerous original papers which reach NATURE office every week in publications of societies and as separate reprints, afford us an idea of the difficulty in which every scientific investigator must find himself. We cannot attempt to do more than mention a few points of prime importance or wide interest selected from these papers; for merely to give the titles of them all would occupy several pages every

week. Every paper received is, however, sent to a contributor familiar with the general subject and not likely, therefore, to overlook anything of outstanding importance. Our columns of Research Items, and short articles which follow them, represent the result of such eclectic surveys of a body of literature which increases in volume every week, and from which limitations of space permit only a few specific points to be described. Nothing more can be reasonably expected in a general scientific newspaper such as NATURE, the main appeal of which is to the scientific world as a whole and not to a specialised section of it.

It is even more difficult to decide how to deal with the great mass of scientific books now published than it is with papers. Within the past four weeks, for example, we have received no less than 150 volumes, almost all of which have distinct characteristics and many of which merit extended notice, on account either of the positions of the authors or the interest of the subjects. It is obviously impossible, however, for us to review more than a fraction of these volumes without destroying the balance and the character of our columns. Our monthly list of Recent Scientific and Technical Books includes bibliographic details of every book received, as well as of others, and this should serve as general guidance to the various works being issued on scientific subjects. By publishing all these titles we are able to do for books what it is impossible to undertake for single papers or memoirs.

As regards reviews, experience shows that those of the essay type, which deal with the subjects of the books broadly and descriptively, are most widely read, and therefore serve the best purposes of both author and publisher. Summaries of the contents of the various chapters of a book, with comments upon them, are more appropriate in prospectuses and advertisements than in the columns of a journal which aims at interesting its readers in the progress of science generally, and not alone in the special portion of the field in which they are themselves working. A review should, however, be a judgment as well as a description; for readers are guided by it in their decision whether to add the book to their libraries or not. Differences of temperament are sometimes responsible for the same volume being praised by one reviewer and condemned by another of equal authority. Some reviewers are always kind, while others are always critical, looking for faults rather than for points worthy of commendation. To this class belonged the reviewer who concluded his notice with the words "We have not found any mistakes, but no doubt there are some." If a book contains a large number of errors, probably the best plan is to neglect it altogether. We prefer not to print lists of such errors, but to send them to the author or publisher, who is always grateful to know of necessary corrections of this kind.

The authors who are never satisfied with the treatment which their works receive are those who evolve elaborate theories, or assert new principles, without sufficient knowledge to understand how untenable their views are. If their works are not noticed, authors of this type nourish the grievance that there is a conspiracy of the scientific world against them. It is useless to publish a short notice stating that the work has no scientific value or is fundamentally unsound. What such authors expect are discussions in detail of the points they raise, though no one else would be likely to be interested in such discussions.

From our point of view, the size of a book affords no standard of the space which may appropriately be given to it. Interest of the subject and distinction of the author are the chief claims to attention. A slender volume may thus be more worthy of extended notice in the form of an essay review than one of a thousand or more pages. With the best intention in the world, however, space cannot be found for adequate notice of all such works now published. Necessity, and not inclination, determines what can be dealt with in this way, and from the rest it is only possible to select some for notice in our Bookshelf columns. What we particularly desire authors and publishers to understand is that the sending of a book for review creates no obligation to publish a notice of it. All that we can undertake is to examine the book and to send it to a reviewer with an invitation to contribute a review of a prescribed length, or to include it in a parcel of books with a request to select a few of the best for notice. The rest appear only in our monthly lists.

Even with these limitations, the congestion of reviews and minor notices is always severe, and we are never able to outrun the flood of literature which continually threatens to overwhelm us. It would be easy to publish every week an equal number of reviews and other notices to that included in the present issue, and yet not exhaust the pile of books which merit consideration. Critical minds may deplore this abundance of printed pages, but to us it seems that most of the books have some original characteristics of style, substance or treatment, and we must confess to a feeling of sympathetic regret for the authors whose works have often to be dismissed somewhat summarily, purely on account of considerations of space. They should be as grateful as we are that leading workers in all branches of science are willing to examine books carefully, and to make some of the volumes subjects of such interesting and useful notices as those which continually appear in the columns of NATURE, and are represented by the reviews included in the present issue.

The Scope of Science.

The Domain of Natural Science: the Gifford Lectures delivered in the University of Aberdeen in 1921 *and* 1922. By Prof. E. W. Hobson. Pp. xvi+510. (Cambridge: At the University Press, 1923.) 21*s*. net.

DR. HOBSON'S important book falls into three main divisions: the first consists of four lectures and describes his general philosophical position, or rather, as he would prefer us to say, his view of the nature of science and its relation to philosophy; the second, being in fact the bulk of the book, comprises fourteen chapters, giving a survey of the development of scientific thought in all its main branches from mathematics to biology; the third, which is a sort of epilogue, brings the book within the terms of the Gifford Trust and deals with the limits of natural science and religion: this is the last two chapters. We will say a few words about each in turn.

Dr. Hobson's general view of the nature of science agrees with that of Mach and Karl Pearson. He explains it carefully and frequently, and arranges the main substance of the lectures so that they depend on this thesis and illustrate it. In this view a scientific theory is "a conceptual scheme, designed by the synthetic activity of the mind, working with the data of perception, for the purpose of representing particular classes of sequences and regularities in our percepts." It has nothing to say as to the reality, or non-reality, of anything behind phenomena, nothing as to efficient or final causes. It is an intellectual shorthand, enabling mankind to deal more and more economically and effectively with the facts of perception which crowd in upon us.

Dr. Hobson is very careful to remind us of the implications of this point of view at every turn in his argument, and it is especially congenial to his own mathematical mind. For this reason he has been able to give us an exposition of the doctrine, quite unexampled in England, if not abroad. Mathematics obviously illustrate the thesis best, and he shows us, *e.g.*, how in dynamics the failure sharply to distinguish the conceptual statement of scientific laws and theories from statements as to percepts has obscured the true nature of science. We can speak and think clearly about a conceptual body moving in conceptual space according to definite numerical specifications, whereas there is no meaning in the assertion that a body moves uniformly in a straight line in physical space. In the same way Dr. Hobson quite rightly treats Einstein's theory of relativity as a conceptual correction of the Newtonian conception: not as a revolution and, above all, not as a new philosophy.

It was certainly a happy thought on the part of the lecturer to turn his general argument into a sort of generalised history of science, and a happy liberality on the part of the Gifford Trustees which enabled them to include it within the corners of their scheme. Histories of science are much in the air just now, and we are constantly seeing small popular books issued on some aspect of the subject, generally biographical. Here we have a survey by a master of the fundamental science of all, who has for years interested himself in general scientific development, and applies an acute, impartial and cautious mind to a statement and an estimate of all the leading theories, especially the more recent, in physics, cosmology and biology. It is a most careful and substantial work which will be of the greatest service to future toilers in the same field. For between the popular histories and the specialist and the philosophical—of which this is an eminent example—there is still a gap waiting to be filled by a concrete, lively, up-to-date survey, such as Mrs. Fisher attempted in the 'seventies and 'eighties.

Dr. Hobson's survey requires careful reading, as it has arisen from careful and thorough thinking and writing. He passes from weighing and delimiting the determinist physical schemes of science to a similar comparison and estimate of dynamical theories. From this to a discussion of the conservation of matter and energy, a sphere which gives him scope for penetrating application of his general theory. What is to be understood by the statement that matter can be neither created nor destroyed? If we mean a substratum, substance itself, not identified with any physical properties, but the bearer of them, we remove our principle from all possibility of verification and make it a bare philosophical assertion with no direct relation to the world of percepts, outside the domain of natural science.

This discussion is followed by a full account of the recent electrical theories of the nature of matter and of the various manifestations of radio-activity. Two chapters discuss cosmical theories and Einstein; four, biology in general, the living organism, heredity, and the evolution of species. In all, the same balanced judgment is maintained, with the same readiness to keep and inculcate an open mind towards the indefinite expansion of scientific truth. Thus, while not accepting the adequacy of any determinist scheme at our present stage of thought, we are not to consider that there are any barriers which will prevent "even larger tracts of phenomena from being correlated with deterministic descriptive schemes." In the realm of life, while allowing full force to the contentions of Driesch and the Neo-vitalists, he tells us that we must be prepared to contemplate as a possibility that the ultimate

answer to the question, "What is the distinction between living and non-living matter?" will be that, within the categories of science as here expounded, there is no final distinction.

One is not surprised to find in the application of this theory of the nature of science to the question of religion, or rather of theism, in the two concluding chapters, that Dr. Hobson's attitude is frankly, completely and impartially agnostic. He examines the various forms of theistic belief very briefly and points out their difficulties. He also—and this is perhaps the most valuable part of this section—indicates the change which has taken place in the line of defence in recent times. In pre-Kantian times the defenders of theistic theories based them on evidences of design, on the objective universe. This Dr. Hobson dismisses with the remark that those who argued from the mechanism of the world to a Great Mechanic forgot that the watchmaker has his material supplied ready to hand: his design consists in the adaptation of the given material to his own idea. The Great Mechanic of the universe has to supply his own material, and it is precisely in understanding the origin of the material itself, the life itself, that the supreme difficulty lies. The more recent arguments from design arise from the purposive activities, the entelechy as Driesch names it, of particular organisms, not from a general purpose in the universe as a whole. The arguments which now appeal most to mankind—apart from these purposive activities of individual living beings—are the need of a Universal Rational Mind to justify and act as a basis to the general intelligibility of the universe; and the moral argument, that we need the conception of an Ideal Being to supply the notions of value towards which mankind is always striving, and which he does not find in the humble origins of life towards which scientific research is constantly pressing him. This latter attitude dates in its modern prominence from the work of Kant. On the former our author aptly quotes from Dr. Rashdall: "We cannot understand the world of which we form a part except upon this assumption of a Universal Mind for which, and in which, all that is exists. Such is the line of thought which presents itself to some of us as the one absolutely convincing and logically irrefragable argument for establishing the existence of God."

Here Dr. Hobson leaves it, being content in this part of his argument, as in the rest, to state the rival positions which he considers either that science has not yet conquered, or that do not properly belong to science at all. For his own view of science, as a man-made scheme bringing together, clarifying and co-ordinating our percepts for our own convenience of thinking and applying our thought to action, a purely human synthesis is quite sufficient. The perceptual domain is such that whole tracts of it, and processes in it, are capable of description by rational schemes; and these schemes are so far justified by successes in the past that we can see no limit to their extension in the future on the same lines. These lines are, truthful observation, the simplest hypothesis which co-ordinates the facts and verification by a subsequent return to Nature. The progress which man has made in framing such schemes so far surpasses what he has achieved either in ordering his surroundings or improving his own nature, that we are justified in treating it as the index of his advance. It was the most remarkable and permanent achievement of the Greeks. Its return in the sixteenth century marks the beginning of the modern world. Its dominance in the present age confronts us with our most serious problems and inspires us with the strongest source of hope for their solution.

F. S. Marvin.

A Reconstruction of Polynesian Culture.

The Belief in Immortality and the Worship of the Dead. By Sir James G. Frazer. Vol. 2: *The Belief among the Polynesians.* Pp. ix+447. (London: Macmillan and Co., Ltd., 1922.) 18*s*. net.

In Polynesian mythology the god Maui, fishing in the waste waters of primeval chaos, hauls up the island world at the end of his line. It requires no less skilful a fisherman to bring up again the Polynesian world of savage life and custom from the chaos of insufficient and scattered data embedded in travellers' and missionaries' records. Sir James Frazer, by the present volume, deserves to take his rank beside the primeval fishers—though his work of rescuing a world in dissolution must have been much less joyous and probably more difficult than that of the earlier sportsmen. Those who know the immense difficulty of extracting truth from amateur ethnographic material, and of giving it scientific and literary form, will be able to appreciate the industry and genius contained in this latest contribution of Sir James Frazer.

There is probably no more fascinating chapter of ethnography than the life and customs of the Polynesian islanders, as they were before European contamination. The present volume is the best all-round picture of Polynesian life available, for here, as in his other books, Sir James Frazer gives more than he promises. The title indicates that the research will be concerned with native beliefs in immortality and with the worship of the dead. In order not to tear the subject out of its context, however, Sir James describes the Polynesian ideas of the next world against the background of their religious and magical

creeds, and these again he places within the setting of tribal life, not forgetting to give us a picture of the physical environment.

Thus, in one archipelago after the other, we receive a vivid though fleeting vision of the lofty volcanic peaks, the forest-clad slopes, and the shaded coral beaches where clearings, smoke, palm plantations, and gabled roofs indicate the sites of villages. We are then led over the settlements, shown the eager gardeners and the skilled fishermen at work, the talented and industrious artists carving and decorating various objects with their fantastic designs, the indefatigable manufacturers weaving mats, shaping and polishing stone implements, building canoes, and erecting huge houses. They are doing all this, in pre-European times, with the aid of stone implements only, without the help of any metal. We see the adventurous sailors setting out on some distant expedition, whether as a semi-religious, semi-dramatic company of wandering performers in the Society Islands, or as a formidable raiding party in Samoa, or as a trading expedition from Tonga to Fiji. We are shown some of the strange and licentious customs of the South Sea Islanders, where a natural exuberance and a touch of artistry redeem them of their cruder features. The ceremonial and festive life of the islanders, culminating in the Areoi performances of the Otahitians, is recorded here in a very complete manner, and the critical caution and constructive talent of Sir James allow us to learn all that is genuine and true about these institutions of which much must, alas, remain for ever a mystery.

It is impossible to summarise briefly this masterly account of Polynesian civilisation, giving due consideration to the differences as well as to the similarities between its various branches. The great uniformity of this culture is indeed remarkable in a people scattered over a wide area in small and isolated communities. Linguistically they are so alike that one must speak, as Sir James does, of one Polynesian language with dialectic varieties. In social organisation they show a remarkable uniformity in structure, with their permanent village communities, with the simple system of kinship terms and the institution of social rank, hereditary and hedged round with taboos and ceremonial observances. Rank gives also political power in a highly developed chieftainship or kingship carried almost to deification. In economic pursuits they are similar, cultivating the same staple plants (taro, sugar-cane, bread-fruit, kava, and palm), and showing the same gaps and developments in arts and crafts.

But, for the student, the differences between the various Polynesian branches are quite as important as their similarities, and the present volume will be of special value and interest just because it does not lump all Polynesians together, but gives a series of monographs, on the Maoris of New Zealand, on the inhabitants of the Tonga archipelago, on the Samoans, the Hervey Islanders, the Otahitians, the Marquesans, and the Hawaiians.

In each chapter, the local beliefs in immortality occupy a dominant position, though always kept in proper proportion within the general picture. It would be useless to summarise each type of Polynesian afterworld. Like their customs and institutions, like their decorative art and mythology, the paradise of these natives is at the same time fantastic and beautiful, quaint and romantic. Born of hope and fear and human presumption, as all such beliefs are, it is a dreamland built up on the pattern of this life, improved and yet formidable, attractive and yet never really desired.

There is no doubt that the beliefs in human immortality, together with the fear of the dead and the hope of their beneficent intercession in earthly affairs, have been among the most important moulding forces of human religion. The chronicles of these beliefs, ranging over the whole world and over all levels of civilisation, which Sir James Frazer is now giving us in one volume after the other, will rank among the most important documents for the study of comparative religion. For the present, Sir James, engrossed in the quest of the immortality of all the peoples of the world, seems to be oblivious of his own: in this descriptive volume, as in the previous one on Australia and Melanesia, he wisely resists the temptation to put forward brilliant theories and daring hypotheses. But those who know Sir James's method realise that before framing any theory he has to study the facts, to collect world-wide material, and examine it by the comparative method. Collected with the author's width and depth of outlook, with his unrivalled grip of sources, and his genius for an all-round presentation, it is given out to scholars, who will thus have before them all the facts bearing on this problem of highest importance. But all anthropologists hope, of course, that there will come a last and crowning volume in this series, in which, as in the fourth part of his "Totemism and Exogamy," Sir James will develop another of his theories which have so greatly influenced modern humanistic thought.

The Rise of Civilisations.

The Cambridge Ancient History. Edited by J. B. Bury, Dr. S. A. Cook, F. E. Adcock. Vol. 1: Egypt and Babylonia to 1580 B.C. Pp. xxii + 704 + 12 maps. (Cambridge: At the University Press, 1923.) 35*s.* net.

THE most valuable and scientific part of this work is the first sixth of the volume, by Prof. Myres, which is an elaborate correlation of Tertiary geology,

climate, conditions of life, and movements of races. Though the detail might be gleaned elsewhere, the realisation of the manner in which each change conditions others, the presentation of the continuity of this pre-history, and the living sense of the realities of existence, put plainly to the reader the complexities of tracing the history of man. Such a mass of detail cannot be at all a final statement; the knowledge that has been gleaned in the last fifty years is much too fragmentary as yet. We can welcome this as a piece of courageous charting, which will show where the blank places lie, and make us realise the value of scattered items which may be fitted into place.

Above all, Prof. Myres has the historical sense which is needed for success in interpreting the facts of anthropology and archæology. His attitude about some essential matters may be noted. He accepts fully the production of skull form and features by conditions of food and life, yet also accepts the racial character of skulls. The waiting problem is that of the time required to alter racial types under different conditions; this is not touched on here, for the good reason that there has been no general study of it as yet, although it is at the basis of anthropology. He accepts the unity of European and Mediterranean changes of level in glacial times; and he takes the longer scale of human relation to glacial epochs, as according better with evidences from the Nile. He regards the Mousterian work, of the third glaciation, as having been annihilated by the Aurignacian people arriving from the S.W. The Solutreans he accepts as coming from the N.E. steppe, perhaps derived directly from Acheulean workers, and flowing across Europe, forming the earliest people of Scandinavia, passing down into Egypt, and also southward to Susa. Thus the unity of culture in these regions is accepted. The Capsian was a ruder style, originating in North Africa and pushing up as far as Belgium, leaving kitchen middens, which point to a communal habit. The Magdalenian people are regarded as only an Atlantic branch of the Solutrean in a harsher climate; but the appearance of that type of work in Egypt seems to show that it was not so local, and would be due to a definite movement of a people.

Coming to later times, the Highland or Alpine people are postulated as extending over all the mountainous region from Armenia to France. When we look at the various races already pushing about in the world, it would be incredible that along two thousand miles of unfavourable country one race should persist without spreading down into better lands on both sides. The type is here derived from the food conditions of a forest people who lived mainly on fruits and roots. The principle of skull type being conditioned by climate and food seems the only explanation of the similarity of Alpine people, and we may talk of an Alpine type, while by descent the people might belong to a dozen different races living in the neighbouring plains. This mountain life appears to confer dominant qualities on the people, when mixed with other races. The so-called Armenoid is supposed to have come from the Asia Minor plateau; but if the type depends on mountain life, why should it not equally have grown in the Lebanon or North Syria?

The supreme value of pottery as archæological evidence is lovingly expounded in two pages, after which there is a careful account of the Lake culture, the Danube peoples, Anau and Susa, the Mediterranean culture, the Beaker folk, the Bronze users, and the Halstatt age, explained by several original maps. This work has laid down the first stage of a science, by forming a continuous and consistent scheme of the whole, by which each fresh detail found will have its value as confirming or correcting this framework of our conceptions.

The other chapters which deal with the age of artistic and written records are sound statements of what is now known, and accessible in other works. The most original parts are on the early Babylonian, by Prof. Langdon, and on the early Aegean, by Mr. Wace. In a volume so crowded with detail there must be many differences of opinion, which it is impossible to note here. The treatment of historical material in general does not freely sacrifice it to the internal consciousness of the German school. We may note in passing that glass was not an Egyptian invention, but was very rarely introduced from some outside source during thousands of years, before it became suddenly very common after the conquest of Syria, 1500 B.C. Glaze was known from the earliest prehistoric age in Egypt, but it is not likely to have been invented by that culture. The long priority of Sumer and Elam before the civilisation of Egypt is well stated by Prof. Langdon.

However much work the writers have put into this book, they have been crippled by the editors not allowing illustrations. The ideal of the publication is far too literary. Even the age of Acts of Parliament needs some material representations to understand it, and to write of times in which the whole evidence is material, without using any illustration, is dancing in fetters. It would be as practicable to write of palæontology without a figure of a fossil, or of geometry without a diagram. The salvation of this work would be to issue an explanatory volume of small figures of everything named here, and in a second edition put in numbered references to the figures.

W. M. F. P.

The Genetics of the Fowl.

Heredity in Poultry. By Reginald Crundall Punnett. Pp. xi + 204 + 12 plates. (London: Macmillan and Co., Ltd., 1923.) 10*s*. net.

MODERN genetics is founded in great measure upon the results of experimental breeding work with material which, in the opinion of the average stock-breeder, cannot be regarded as a "real" animal. To him, *Drosophila melanogaster*, and all that pertains thereto, is far too remote to have any bearing upon the peculiar problems of the man who raises stock for profit. He does not understand why Drosophila is unique as genetic material. The experimental biologist must have an animal with few and heteromorphic chromosomes; it must be easily and cheaply kept under laboratory conditions; it must exhibit a very varied characterisation and it must breed rapidly, producing large numbers of offspring in each generation.

It has to be confessed that to the breeder of pedigreed stock, the geneticist has but little to offer that can be applied with profit to the art of breeding specimens of the established breeds—and this is the occupation of the most successful breeders. The breeder has drawn up his own standards of excellence, usually in absolute ignorance of the scientific principles which undoubtedly underlie his art, often indeed in direct defiance of these principles, and has set himself the task of attaining them. In many cases he has succeeded, and it may be accepted that the success of the makers of the modern breed of domesticated animals must have been achieved by methods which were not violently in discord with the principles of heredity which have been disclosed comparatively recently by the geneticist. But these principles were in operation long before the geneticist discovered them, and it was not to be expected that their discovery would result in any profound modification of the breeder's practice. Certainly, the science of genetics can offer to the breeder of pedigreed stock the means of interpreting his successes and his failures, but it is to the creator of new breeds, to the improver of the old, that it can promise most. It can offer more to the breeder of highly fertile, quickly-reproducing stock than to the breeder of cattle or sheep.

Moreover, since at the present time almost the entire weight of the modern chromosome theory of heredity is carried by the dipteran Drosophila, the British geneticist is seeking other suitable experimental material. The organisation of the National Poultry Institute has provided him with a unique opportunity of employing the fowl: there can be no better material for the geneticist working in a research institution, the function of which is to aid the breeder in the solution of his problems. Research is being more and more concentrated in institutes, and above their doors the slogan "Knowledge for its own sake" is not inscribed. In such institutes it is necessary to use material with which the community at large is acquainted, so that its co-operation may be secured, and after all, the study of the phenomena of inheritance in the fowl is equally as thrilling as that which centres around Drosophila. The geneticist cannot readily aid the fancier who is dealing with characters so fine that from the point of view of genetics they demand an outlay in expenditure and meticulous attention by no means commensurate with the theoretical value of the results likely to be obtained; but his interests coincide with those of the utility poultry man who is eagerly demanding knowledge of the mode of inheritance of such characters as fecundity, broodiness, egg-colour, and fertility. The geneticist can, in using the fowl as his material, add considerably to our knowledge of the principles of heredity, and at the same time can bring much-needed assistance to a most worthy section of the community.

Indeed it was with the fowl that Bateson, more than twenty years ago, first showed that the principles enunciated by Mendel, then newly discovered, applied to animals as well as plants. It is certain that had the work of Bateson and Punnett, which immediately followed this, been properly appreciated and adequately financed, the present position of British genetics and of the science of genetics applied to animal breeding would have been very different to-day. It is true that Prof. Punnett has been carrying out experimental breeding work with poultry for twenty years, and that, as his book indicates, he has made most valuable contributions to our knowledge of the genetics of the fowl; but what he has done is but a fraction of what he could have done, had he not been embarrassed by insufficient material and inadequate accommodation.

It seems that at last Prof. Punnett's difficulties are to be removed, for under the auspices of the National Poultry Institute he is to be given the opportunity of carrying on his work under satisfactory conditions. At one time it seemed as though the scheme would fall through, for the response to the appeal for subscriptions towards the funds of the Institute was somewhat tardy. His book appeared most opportunely and greatly strengthened the appeal of the leaders of the poultry industry in England. It showed clearly what had been done by the geneticist working under difficulties, and provided a vision of what could be done when these difficulties were removed. Its reception by the poultry breeders of the country provided an

indication of the eagerness with which the "practical" man is turning to the man of science for information. To the poultry-breeder this book is indispensable, for it gives a concise picture of all that has been done by the geneticist working with poultry up to the end of 1922, and no poultry-breeder can afford to disregard the facts with which the book is crammed. To the biologist the book will have a different interest: it will serve as a landmark in the history of the genetics of the fowl, for in the next decade great advances are due. In America, in Australia, in Russia, and in Britain, much concentrated experimental breeding work is in progress. The phenomena of linkage are now being investigated, but owing to the greater complexity of the chromosome constitution—there are seven large pairs and at least nine small pairs of chromosomes, it appears—it cannot be expected that progress will be as rapid and spectacular in the fowl as it has been in the case of Drosophila. To those of us who are working with the fowl this book is a great stimulus: Prof. Punnett's 1933 edition shall bear witness to what the geneticist can do, given opportunity.

F. A. E. C.

Essence and Existence.

Scepticism and Animal Faith: Introduction to a System of Philosophy. By George Santayana. Pp. xii+314. (London, Bombay and Sydney: Constable and Co., Ltd., 1923.) 12*s.* net.

The Life of Reason: Or the Phases of Human Progress. By George Santayana. Second edition. In 5 vols. Vol. 1: Introduction and Reason in Commonsense. Pp. xix+291. Vol. 2: Reason in Society. Pp. viii+205. Vol. 3: Reason in Religion. Pp. ix+279. Vol. 4: Reason in Art. Pp. ix+230. Vol. 5: Reason in Science. Pp. ix+320. (London, Bombay and Sydney: Constable and Co., Ltd., 1923.) 8*s.* net each vol.

MR. SANTAYANA has a wonderful gift of expression and writes with a distinction and charm which are an unending source of delight. Yet he leaves his readers with a strange unsatisfied feeling not free from a touch of resentment. He is a true poet, who can write prose with all the rhythm of verse. Born in Madrid of Spanish parents, he tells us that he has chosen our language for his literary expression, though it is not his native tongue, because he considers that so far as containing truth is concerned one language is as good as another, and he prefers ours. Also, what is truly admirable in a philosopher, he finds it adequate. When we read, however, his sustained but pleasant and well-balanced soliloquising, we cannot but wonder why he should suppose that we are interested in his want of interest in what interests us. Yet this is the whole burden of his philosophy.

Mr. Santayana told us in a recent book that when the War came it found him at Oxford, and he remained there, apparently because he could look on without taking part, indifferent to the result, and comparatively undisturbed. He was content to leave the issue to the statesmen and soldiers; the folly and the wickedness of it might sadden him, but his care was that it should not attach him or invade his philosophic calm. In the same spirit he now contemplates the scientific revolution in mathematics and physics which has produced in our time an intellectual upheaval. It interests him, of course; he thinks it may mean that he is living to see the emergence of a new concept of nature, a new cosmology, comparable with those of Heracleitus, Pythagoras, or Democritus, but as a philosopher he has no part in the matter, and the issue, whatever it be, will not disturb him. He glories in the fact that he does not understand the new principle and is easily and comfortably warned off the attempt to understand it. He knows he has not the technical equipment of the mathematician, and so he must and will accept the new discovery whenever the mathematicians and physicists tell him they are agreed.

It is possible there are many students of science who will heartily approve this maxim of the aloofness of philosophy from all actual scientific research. It seems to express exactly what the great scientific leaders of the nineteenth century were always insisting on, the positivity of physics, the speculative nullity of metaphysics. Gladly will they respect the moralising, soliloquising, mysticising philosopher, especially if, like the author we are considering, he be endowed with poetic genius, so that he will not interfere with the stern experimental work in which science is engaged. But if that ideal would suffice for the last century it fails utterly to satisfy the present. The coming of the theories of relativity has changed the whole aspect of the scientific world and the whole attitude of men of science to philosophy and of philosophers to men of science. Science and philosophy are now engaged in a conjoint undertaking, the adaptation of the human mind to a new cosmogony forced upon it by the necessity of fitting experimental facts into natural conceptual frames.

What then, in the present state of our science, has Mr. Santayana to tell us which is positive? What is the substantive part of his contribution? He has something very definite to say, and whether he knows it or not, and whether he cares that it should be so

or not, it proves to be singularly in accord with the significance and direction of the new scientific theories. He tells us he is a materialist, but adds that it may be he is the only philosopher who is. All that this seems to mean is that, with Spinoza, he seeks the unity of the world in an objective and deterministic principle rather than, with Leibniz, in a subjective and creative principle. He is no more materialist in the ordinary acceptation of the term than Spinoza is atheist. His theory, however, merits the attention of experimentalists.

His theory is that "existence" is not a datum. We can have no image of it and no idea of it. We accept it with "animal faith." What is "given" to the mind in knowledge is not the *existence* of objects but their *essence.* This is true of the mind itself, of the *cogito ergo sum,* equally with the objects of the physical world. Essence is not a subjective eject: it is objective in the fullest meaning of the term. This rejection of existence as a datum is of special significance in philosophy, for it serves to separate Mr. Santayana from the realists with whom his "materialism" would seem naturally to associate him, from those who, like Prof. Alexander and Prof. Lloyd Morgan, insist on the importance of assuming the existence of the non-mental world, even though it may need to be accepted "with natural piety." But it is of peculiar significance in science; for if Einstein and the orthodox relativists are right, science has no longer any use whatever for this relic of an older world-view and its pious preservation is a superstition. Santayana's doctrine therefore, which does not reject existence but denies that it is a datum and excludes it from knowledge, is singularly in accordance with the theory that in physical science we are not contemplating absolute existence but co-ordinating phenomena by means of invariants. The "animal faith" which makes us believe the existence of a datum is not the philosophising will to believe or reason for believing: it is the ordinary man's intuition or instinct.

What then is essence, or rather what are the essences, which Mr. Santayana presents as the objective reality of things known? To the philosopher it is perhaps enough to say that they are the Platonic Ideas interpreted in a modern way, a concept which recalls Croce's æsthetic images, except that essences are not the creations of a *fantasia,* or the expressions of intuitions, but passively discerned objects. We are more interested, however, to know what is their status in science. They are, we are told, the indispensable terms in the perception of matters of fact and they render transitive knowledge possible. They are distinguished therefore from "bits of sentience" or pure sense-data, on one hand, by their external reference and from existents or pure existences, on the other hand, by their relatedness. The value of the doctrine to science is then that it takes us behind all such philosophical distinctions as primary and secondary qualities, universal and particular ideas, abstract and concrete terms, giving us at once what is ultimate in the reference to reality. Mr. Santayana takes as an illustration the colour quality "yellow." I may see a buttercup, the intuition is then a sensation; or I may see it with my eyes shut, it is then an idea or a dream; or I may see it with my eyes open when there is no buttercup there, then it is hallucination. Whatever be the difference in the mode of apprehending or in the object of reference, the essence yellow is one and identical.

To see the relevance of this theory to scientific research we have only to recall the endeavour of Mach to construct science out of the relations of sense-data. Mach found he had to fall back on a quite arbitrary hypothesis of parallelism. How different his task might have appeared had he had this conception of essence. His difficulty was to get to existence, and this demands belief. If, on the contrary, with Mr. Santayana, we start from the realm of essence, which demands no belief, we may at once find conclusive reasons for believing that sundry intuitions of parts of it exist in fact. This discrimination of essence brings too a wonderful clearness to the comprehension of the nature of scientific research. All data and descriptions, all terms of human discourse, are essences, inexistent. Existence is an intuition, inexpressible, not knowledge but ignorance, a purely animal faith. The distinction cuts science free from all the perplexities and antinomies which arise when reality is identified with existence (*e.g.* the non-existence of the past and future, the inextensiveness of the present).

Having expounded this important distinction of essence and existence, Mr. Santayana then proceeds, somewhat to our surprise and with at least the appearance of complete inconsistency, to select from the essences the philosophical concept of substance and the naturalist concept of matter to be the foundations of his new Jerusalem, a system of philosophy which we are led to expect is shortly to appear. We look forward to it with deep interest, for the present introduction shows him inspired with a new vision and emboldened to undertake constructive work. His book closes with a critical epitome of the history of modern philosophy in which, except Spinoza, each leading philosopher is pelted with epigrams, and ironically dismissed.

H. Wildon Carr.

Evolving Biology.

Outlines of Evolutionary Biology. By Prof. Arthur Dendy. With Glossary of Technical Terms. Third edition, revised and enlarged. Pp. xliii+481. (London: Constable and Co., Ltd., 1923.) 16*s*. net.

WE extend a welcome to this revised and enlarged edition of an exceedingly useful book, which has been a favourite since it was first published some ten years ago. It is an introduction to the study of the principles of biology, well thought out by a teacher of experience, who has himself made important contributions to the science. There are five parts, dealing with the following subjects: the structure and functions of organisms and the cell theory; the evolution of sex; variation and heredity; the theory and evidence of organic evolution, with particular insistence on adaptations; and, finally, the factors of organic evolution. What gives the book its particular merit, in addition to the indispensable qualities of lucidity and good judgment, is its concreteness. Prof. Dendy is always bringing the student into touch with concrete examples which illustrate the principles discussed and enable the reader to get a firmer grip.

There is throughout the book a scientific good humour. Thus when the author is discussing such a thorny question as the transmissibility of individually acquired somatic modifications, he is temperate in his language and judicial in his survey. He does not dogmatise and he does not suggest that the only tenable position is Lamarckian; and yet he is not in the least wobbly, as this quotation may show.

"On the whole, then, the available evidence seems to indicate that suddenly and exceptionally acquired characters, such as mutilations, are occasionally but only rarely inherited to such an extent as to be recognisable, while, on the other hand, characters which are due to the continued action of some external stimulus, extending perhaps over many generations, in the long run become so firmly impressed upon the organism that they affect the germ cells as well as the somatic cells and thus become truly blastogenic."

We happen to think that this is a misinterpretation of the evidence, but our point is that Prof. Dendy puts the problem before the student in an eminently fair-minded fashion.

The author wishes good speed to the investigators of the chemical and physical processes that go on in the living body, but he denies that the formulæ of chemistry and physics can be made to cover all the phenomena of life.

"We may, perhaps, believe that, as living matter became more and more complex in its structure, it entered progressively into new energy relations with its environment, which became more and more unlike those exhibited by inanimate matter, until at length they passed in some respects altogether beyond the reach of chemical and physical explanations."

This appears to us to be, on the whole, the scientific position at present, though the wording is a little suggestive of the idea that mind is a resultant of complexifying proteins and energy-relations, which is absurd, as Euclid used to say when he was tired. Moreover, it is open to question whether there is any "inanimate matter" anywhere. But what we wish to say is this, that if we shared Prof. Dendy's non-mechanistic views, as we do but more also, then we should not entitle a chapter "the mechanism of evolution." The point is that evolution transcends mechanism, and, if that is so, it is a pity to say mechanism when you only mean *modus operandi*. For there can be no doubt that if one says "mechanism" often enough in reference to vital processes, people will end in believing us, and we shall believe it ourselves!

We have referred only to a crumpled rose-leaf, for we really think that the book is as good as any book has a right to be. It is singularly attractive in every way—beautifully printed, with many interesting illustrations of great interest; and it is a personal deliverance. Most alteration, naturally, has been made in the part dealing with heredity. There is a valuable glossary, but we think it was a psychological mistake to put it in the forefront of the book. What a thorny hedge to these fair pastures!

Natural History of Pheasants.

A Monograph of the Pheasants. By William Beebe. In 4 volumes. Vol. 4. Pp. xv+242+23 coloured plates+27 photogravure plates+6 maps. (London: H. F. and G. Witherby, 1922.) 12*l*. 10*s*. net.

THE fourth and final volume of this great Monograph[1] treats of the golden pheasants (Chrysolophus), the bronze-tailed peacock pheasants (Chalurus), the peacock pheasants (Polyplectron), the ocellated pheasants (Rheinardius), the Argus pheasants (Argusianus), and the peafowl (Pavo).

These groups comprise forms of surpassing beauty of plumage and remarkable habits. The life-histories of a number of the species treated of were previously unknown, since no ornithologist had ever penetrated the remote fastnesses in which their lives are spent, while in the case of others much remained to be learned. Mr. Beebe's researches have lifted the veil which has hitherto masked the ways of many.

To the illustration of the seventeen species and subspecies here described, twenty-two coloured plates

[1] Previous notices relating to this Monograph appeared in NATURE, vol. 102, p. 302; vol. 107, p. 235; and vol. 110, p. 105.

are devoted; twenty-seven exquisite photogravure plates depict their haunts, nesting sites, courtship and dancing places; while a series of maps illustrate the geographical distribution of all the forms.

Regarding the two species of Thaumalea, the golden and Amhersts' pheasants, though both have long been familiar in captivity or in a semi-domesticated state, yet little or nothing was known of them in their native haunts. This is well illustrated by the case of the former bird. Although this beautiful species has been kept in captivity for centuries (even prior to 1747 in England) yet in a wild state probably no other pheasant was so absolutely unknown to naturalists. Mr. Beebe, however, succeeded in penetrating the bird's exceedingly remote retreats and gives a graphic account of its home-life in the deep rugged mountain forests of Central China. Here he witnessed its wonderful courtship, in which the gorgeous ruff of the male plays an important part, but all his endeavours, however, to find its nest were unavailing, and it still remains to be discovered. The same great difficulties were experienced in the search for the Amhersts' pheasant. For many days the bird remained but a phantom, until at last a glimpse of "its royal self" was presented in its remarkably fine home in the forests on the frontier of Yunnan and Burma, where it haunted the steep sides of lofty valleys traversed by rushing torrents. Here the author saw the cocks in all their glory of ruff and body-plumage, and beautiful beyond description. Apart from the pleasure of recording their actions, Mr. Beebe was not able to add much to the little already known, and failed to find a nest.

From discussing the typical pheasants the author proceeds to treat of those of the Argus group (Argusianinæ), commencing with the bronze-tailed peacock pheasant (Chalurus). This genus includes two species which are confined to the Malay States and Sumatra respectively. Both are rare in their native haunts and in collections, and have never been kept in captivity. Practically nothing was known of their life-histories prior to the author's investigations. The Malayan species (*C. inopinatus*)—"a true bird of the wildness"—inhabits the dense jungles of the central mountains of the Peninsula. Hitherto the knowledge of this species has been derived from skins, and many days passed after Mr. Beebe reached its haunts, which ranged from humid dark ravines to summit ridges where warmth and brilliance prevailed, ere he was able to catch even a glimpse of the bird. Eventually he came across a party from which he secured a specimen, and was shown a nesting site on the side of a rocky defile. The Sumatra species (*C. chalurus*) is an inhabitant of the interior of that great island, where no white man has seen it alive.

The peacock pheasants (Polyplectron) are ornamented with many gorgeous metallic eye-spots, which are most developed in the male and are displayed by him during courtship. Mr. Beebe found the grey-backed species (*P. bicalcaratum bicalcaratum*) occurring singly or in small families among the mountains of Burma and Western China, where they are shielded by terrible growths of thorn cane. They seldom fly, but skulk through the jungle in the day-time and roost on trees at night. Once the haunts were discovered they were found to be not very uncommon, and their courtship, one of the most remarkable among birds, was seen to commence with a lateral display, although the climax was reached in a wonderful frontal performance in which every ornament of the male's plumage was brought to bear to influence the little female. The Malay species (*P. malaccensis*) is a native of lowland jungle where it is well guarded by a myriad tropical terrors which rise at every foot to dispute advance into its domain. It proved to be the most difficult of the Malay pheasants to locate. Day after day the search had to be given up, and it was only when Mr. Beebe resorted to tracking by himself alone that success came, and even then he had to fight his way and suffer much for even a brief peep of these splendid birds. At last, however, in a land of dreadful silence, leeches, sand-flies and mosquitoes, he found the objects of his search in fair numbers. The Bornean species (*P. schleiermacheri*) is a native of the hilly jungle near the centre of the island. Of this species the author was only able to obtain a handful of feathers from a bird trapped by a Dyak, nor could he learn anything trustworthy about this pheasant from the natives, who are well versed in all the other species. Hence he concludes that it must be exclusively uncommon. Of the three other species of this genus, *P. katsumatæ*, *P. napoleonis*, and *P. bicalcaratum germaini*, he was unable to visit the haunts in the Islands of Hainan and Palawan and in Cochin China and Siam, but he gives accounts of their histories so far as they are known.

The ocellated pheasants (Rheinardius) are large birds as strange in appearance as they are rare and mysterious in life. Their general characters unite them closely with the Argus pheasants, but they are much less specialised. Like them they have the remarkable habit of clearing small tracts in forests as arenas for their displays. Two forms are known. The Annam species (*R. ocellatus*), a magnificent bird, has a singular history, for its identity was founded on several feathers, from an unknown source, discovered in the Paris Museum prior to 1856; but it remained undescribed, and it was not until 1882 that a specimen procured by Commander Rheinart set

all doubt at rest as to its distinctness. Very few examples have been obtained from its haunts in the dense mountain forests which separate the Laos country from Annam—a region which is inhabited by semi-savage tribes. The Malay species (*R. nigrescens*) is also very rare, and only a few specimens were procured among the central mountains of the Peninsula. Mr. Beebe tells us that it is the most mysterious of all the birds of the Argus group. He lived in their neighbourhood, heard their calls, found a dancing arena of an individual that had met with disaster, and yet, after weeks of search, he never caught a glimpse of the bird itself.

The Argus pheasants (Argusianus), of which three species are known, Mr. Beebe regards as being in many ways the most extremely ornamented and specialised members of the pheasant family. The adult males measure six and a half feet in length; two-thirds of this is taken up by the central tail-feathers, while "the ocelli on the secondaries are marvels of design and shading, resembling marble-like spheres revolving in separate sockets, and all with bright lights as exquisite and effective as if carefully planned for some exact and delicate purpose." The evolution of these "eyes" is illustrated in one of the coloured plates. The males make, and keep clear, large dancing areas in which they call the females and where they show off their marvellous frontal displays. Regarding the Malay species (*A. argus*) and the Bornean bird (*A. gnayi*), the author tells us that few white men have shot or seen them in their wild homes, owing to the fact that "no deliberate attempt has been made to circumvent the birds, or to adapt one's approach to the peculiarities of life habits." Hence he was very anxious to make as thorough a study as possible of these marvellous creatures. At first he was pessimistic, being told that he would not be able to get further than hearing the birds. Many of their habits are affected by their curious practice of creating special places—a cleared arena about three yards in diameter—in the forest jungle, where the male displays before the female. Mr. Beebe found that it was here alone that he could observe the birds, and, having made good use of this discovery, he has been able to give elaborate descriptions of what he observed. The third species, the double-spotted Argus pheasant (*A. bipunctatus*), is only known from a portion of a feather, without a history, found in the British Museum in 1871. This differs so decidedly from any corresponding feather in the known species, that the author has little doubt that it represents a distinct form.

For the two species of peafowl, Mr. Beebe has established a sub-family (Pavoninæ) "on account of the character of the tail moult, which typically is from the central pair outward." They also "form a distinctly isolated group, and we have no idea of their line of ancestry. The femoro-caudal muscle, for example, is absent in Pavo and in Meleagris [the Turkeys] while present in all other gallinaceous birds; the syrinx in Pavo is simpler than in any others of its family." Of the two species, the well-known Indian bird (*Pavo cristatus*), from which the domestic bird is descended, is a native of India, Assam, and Ceylon. Its habits are well described by the author from personal observation. Semi-domesticated peafowl occur in many parts of India and are considered sacred birds; while the black-winged form is a very remarkable sport or mutation occurring sporadically among domestic Indian birds, sometimes one or two appearing in a brood. Albino birds are never found in a wild state. The second species, the green peafowl (*P. muticus*), is a native of Chittagong, Burma, Siam, Cochin China, Malay Peninsula, and Java. The habits of the two species are almost identical, where Indian birds only are considered; but even where the green bird is most abundant, it occurs in small isolated groups, which are extremely sedentary.

Mr. Beebe is to be heartily congratulated on the completion of his great work. Many excellent Monographs devoted to various groups of birds have appeared, including princely volumes on the pheasants, but no treatise on any group has ever been so enriched by the researches of its author as this. Yet, Mr. Beebe, great traveller and naturalist as he is, only achieved success with many species through his unfailing enthusiasm and a remarkable display of indomitable determination. Indeed he failed only where success appears to have been humanly impossible.

W. E. C.

Vitamins.

Vital Factors of Foods: Vitamins and Nutrition. By C. Ellis and Prof. Annie L. Macleod. Pp. xvi + 391. (London: Chapman and Hall, Ltd., 1923.) 25*s.* net.

If there still remain people sceptical of the existence of what have been called "vitamins," this book should go far to convince them that there are certain elusive substances, present in food only in the most minute quantity, but nevertheless necessary to enable growth to take place and to maintain normal health. The reviewer is unaware of the publication of any other work on this subject of so comprehensive and impartial a nature as the present one. In a branch of knowledge on which so much research is still being carried on, it is not to be expected that the very latest discoveries should find their way to a text-book, but that of Ellis and Macleod appears to have

omitted little or nothing up to the date of its production. It will be found very useful.

Like most new and far-reaching discoveries, that of vitamins has not escaped the danger of being regarded as displacing or reducing to little importance previous work on such matters as the energy value of food. While it is perfectly true that, in the absence of vitamins, no amount of food, however great, suffices for health, it is nevertheless equally true that no amount of vitamins can compensate for a lack of energy value. In actual practice, however, there is, under certain conditions in which fresh vegetable food is absent from the diet, more risk of damage to health from this factor than from absence of total quantity. Such, for example, is the position of those populations which live mainly on rice, or in circumstances in which preserved or canned food is the chief article consumed.

The reviewer is glad to note that the authors have adopted Drummond's suggestion of dropping the final *e* of the original name "vitamine" and appending a capital letter to express the particular kind of vitamin referred to. This practice is rapidly being generally adopted, since it is, on the whole, more satisfactory than any other that has been advocated. The origin of the name will soon be forgotten and it will become just a name, like "enzyme," which does not suggest yeast whenever it is used. In connexion with the title of the present book, it may be noted that there are other factors of food equally as "vital" as vitamins. The term "accessory factor," sometimes used, is apt to suggest, on the other hand, that these factors are only of subsidiary importance.

A brief account of the elementary principles of nutrition precedes the main subject. This appears to contain all that is needed for the purpose. We may ask, perhaps, if water, salts, and vitamins are to be added to the traditional fats, carbohydrates, and proteins as necessary constituents of a diet, why omit oxygen? The first chapter is devoted to a general account of the nature of vitamins, with a history of their discovery. It is pointed out that we do not know how they act. In many ways they behave like catalysts; in other ways, they seem more related to the chemical messengers or hormones. McCollum directs attention to the fact that they do not behave as hormones in the sense of being produced in one organ for the purpose of bringing about reactions in other places. They are not formed by the animal organism at all, so far as we know.

A useful account of experimental methods is given in the second chapter. It is to be feared that inattention to freedom from traces of vitamins in the control diet has been the source of erroneous statements. As to their chemical nature, we have still practically everything to learn. Like enzymes and hormones, they are so extremely powerful that we can remove more and more unessential impurities from them, without affecting their activity. Thus we finally arrive at a trace of a substance which has very few chemical properties of any kind. Some method by which these substances can be readily separated from large quantities of the materials containing them has yet to be worked out. Possibly it may be found in an application of the adsorption method used with success by Willstätter in the case of enzymes.

The making of concentrated preparations is described, but it is to be regretted that the extravagant cost of commercial products in relation to their actual content in vitamins is not more insisted upon. As Drummond has well pointed out, eggs and oranges are equally useful at less than a fiftieth of the cost. If a reasonably varied diet with fresh fruit and vegetables be taken, there is no need to worry about vitamins. It is curious that so many people fail to realise that vitamins are not drugs, to be taken under medical direction, but natural constituents of food. It does not matter how much of them be taken, provided that it is enough.

Detailed discussion is given of the various disorders associated with deficiency of vitamins. It is here that the question as to whether there are more than the three (A, B, and C) vitamins comes into prominence. Three chapters are devoted to practical problems of appropriate diets for infants and adults, and a final chapter on the interesting question of the vitamin requirements of fungi, moulds, and bacteria is added. An appendix gives tables of the distribution of the vitamins in various articles of diet. It is a remarkable fact that although some animal products are rich in certain vitamins, the ultimate source of these appears to be in all cases the vegetable kingdom.

The book may be highly recommended. The work of so many different investigators is given that the reader is at times rather bewildered, and a summary of the established data, given at the end of each chapter, would be a welcome addition. There is, however, an excellent index. W. M. Bayliss.

The Atom of To-day.

The Structure of the Atom. By Prof. E. N. da C. Andrade. Pp. xv+314. (London: G. Bell and Sons, Ltd., 1923.) 16*s*. net.

To give a comprehensive critical survey of the prevailing theories of atomic structure and to indicate their triumphs and inadequacies in a volume of reasonable size is the professed object of the book under

review. This is a bold design. It is all the greater pleasure therefore to record that the book is an almost unqualified success. It is, moreover, heartily welcome, for it provides just that critical introduction to modern atomic speculations which should be in the hands of every student, and can be read with profit by most researchers. Such a book has until now not been available in English, and the want is scarcely filled by the recent translation of Sommerfeld's classic work, which is rather too long and elaborate and somewhat too one-sided (spectroscopic) to be entirely suitable in this connexion.

To come to details. The book is divided into two parts dealing with the existence and properties of the nucleus and with the extra-nuclear structure respectively. In Part I. after a short historical introduction, the first evidence for the exceedingly open structure of the atom is presented in detail, as derived from the passage of swift corpuscles through matter. An important feature is the account of the work of Lenard on the absorption of swift cathode rays, now too often overlooked, which started atomic speculation on its present path. There follows an excellent account of the work of Rutherford in establishing the nuclear structure, with its extensions by his school, and then the radioactive evidence, including the recent work of Ellis on the photoelectric effect and the interesting speculations of Meitner. There is next a discussion of the modern work on very close collisions between α-particles and light nuclei—artificial disintegrations by Rutherford, and the deviations from the law of inverse squares. A chapter on positive rays, with Aston's law of integral atomic masses, concludes the nuclear evidence. In this chapter there is one of the few questionable omissions. In a paragraph on the separation of isotopes, Harkins's work on hydrogen chloride is alluded to, but there is no mention of the very elegant work of Brönstead and Hevesy on mercury.

Part I. then concludes with a critical account of such theory of the nucleus as is yet possible, and two short but necessary digressions, one on X-rays from the classical point of view, and the other on the general empirical laws of optical spectra. Both are good, but exception can be taken to smaller points in the optical chapter. To emphasise the fact that the majority of known atomic spectra have not yet been ordered into series is to overlook the fact that the time is still short during which there has been a real theoretical incentive so to order a difficult spectrum. But the yearly output of such spectra at least partially ordered in series is now considerable. Again, it is unfortunate that it has been stated that atoms in general emit *two* optical spectra, when we now have Al III and Si IV. But this, no doubt, like the statement, already partly untrue, that there is no detailed theoretical foundation for optical terms of the forms of Rydberg and Ritz, is evidence rather of the present rate of progress than of inadequacies in the book. The general theory of these term-forms was announced by Bohr at the recent meeting of the British Association.

Part II., on the extra-nuclear structure, starts with two long chapters on the dynamical model of atoms of one and more than one electron. Clear as they are, these are the least satisfactory chapters in the book; we return to their consideration later on. They are followed by a concise account of Bohr's general theory of atomic structure, which could perhaps be bettered in minor points. The discussion of firmness of binding compared to orbits of the same quantum number in hydrogen could be made clearer by an explicit definition and use of "the effective quantum number" of the external Keplerian loop of the orbit and its relation to the actual total quantum number. Again, no clear distinction is made between the true relativity effect on a Keplerian orbit and the similar effect due to deviations in the law of force from the inverse square, such as occur in practice from the variable screening. Finally it is stated in error that the fifth and sixth electrons are bound in 2_1 and the thirteenth and fourteenth in 3_1 orbits—a statement contradicted by the relevant table on page 224. The error repeats an early statement by Bohr, which he has superseded by this table.

Following this there is an excellent sympathetic account of static models of the atom and their value in organising the facts of chemistry. This chapter makes it clear in an interesting way that though all attempts to make static models with any natural physical reality are a waste of time, such models, like the elastic spheres of the kinetic theory, have a large legitimate "place in the sun." The book concludes with what should prove a very useful survey of the present chaotic state of magnetic theory.

To return to the chapters on the dynamical atom. The reviewer would make the general criticism that they present the subject from a point of view which, without prejudice, may be called too "Sommerfeldian." Without in any way belittling Sommerfeld's classical contributions, it is the correspondence principle and the fundamental frequencies of the atomic system, Bohr's method of attack, and not the Wilson-Sommerfeld quantum conditions, which ought to be made fundamental, above all in a book for physicists. "Ought" is the word, for reasons which the author of this book has himself formulated as clearly as possible, for this is the method which seems to work best, and to be in closest touch with physical reality. His prefatory quotation of Kelvin should be re-quoted—"Nothing can be more fatal to progress than a too confident reliance on mathe-

matical symbols; for the student is only too apt to take the easier course, and consider the formula and not the fact as the physical reality." In effect this makes the section on elliptic orbits sad reading; we are also given Sommerfeld's admittedly unsatisfactory attempt to give a theoretical basis for Ritz's term-form. It is much to be desired that we might have had instead Bohr's elegant proof of the Rydberg form for central orbits (now superseded, as mentioned above), which is both physically and mathematically unexceptionable. It is possible that this was not available to the author, though it has been current for some time.

It is only just and right, however, that this review should close as it began on a note of praise, for the merits of the book are many and its defects few. No one can have anything but praise for the system and selection of references which leave nothing to be desired, and for the exquisite photographs by Blackett, Aston, Paschen, Siegbahn, and de Broglie reproduced in the four plates. The book should go through many editions—the more the better.

R. H. Fowler.

The Physical Aspect of Physiology.

(1) *Interfacial Forces and Phenomena in Physiology: Being the Herter Lectures in New York in March, 1922.* By Sir William M. Bayliss. Pp. ix + 196. (London: Methuen and Co., Ltd., 1923.) 7*s.* 6*d.* net.

(2) *The Vaso-Motor System.* By Sir William M. Bayliss. (Monographs on Physiology.) Pp. v + 163. (London: Longmans, Green and Co., 1923.) 7*s.* 6*d.* net.

(3) *The Electrical Action of the Human Heart.* By Dr. Augustus D. Waller. Edited by A. M. Waller. Pp. ix + 103. (London: University of London Press, Ltd., 1922.) 7*s.* 6*d.* net.

HOWEVER distinguished a man of science may be, we still expect the books he writes to increase his reputation. These two books by Sir William Bayliss will scarcely do this. It is not that they are bad books, but that they are not good enough for so distinguished an author.

(1) The volume on "Interfacial Forces and Phenomena in Physiology" is lucid and readable, and will certainly stimulate to further thought many who are interested in the problems lying on the borderland between the physical and the biological sciences; but here its virtues end. In the first chapter we are introduced to the electron theory of the atom and the latest work on crystal structure; but the promise of this chapter is not maintained. The treatment of the subject is almost exactly the same as that in the first edition of the author's "Principles of General Physiology." Though the advances of the intervening seven years are mentioned their bearing is not always recognised. For example, Sir William Bayliss persists in calling protein solutions "emulsoid," while confessing that emulsions never behave like protein solutions, and he makes no use of the insight into the constitution of colloidal solutions that the work of McBain gives us. It is probably the hypnotic effect of the word "emulsoid" that makes the author assume that a protein solution must inevitably behave as a heterogeneous system.

The classical theories of surface tension and adsorption are all based on statistical mechanics, and it is just when we come to the mechanism of the living cell that statistical theory fails us. These theories have been available to physiologists for many years and have been of scarcely any use because no precise deductions can be made from them in connexion with physiological problems. The new treatment of surface phenomena that we owe to Langmuir and to Adam holds immense possibilities for the physiologist, yet Sir William Bayliss dismisses Langmuir almost summarily. There are cases where statistical theory is of use to physiologists, notably in the treatment of processes that go on in a relatively simple medium, such as blood. The particular theory that has proved of most use here is the Law of Mass Action, but this law we are told we ought not to use. Sir William Bayliss adopts the attitude of one who reproves a friend for removing a nut with hammer and cold chisel, while he admits that the only spanner available does not fit.

(2) The book on "The Vaso-Motor System" is more purely technical. It contains a useful summary of the work done on the control of the blood flow through arteries and capillaries. Much of the evidence at present available is confused and conflicting. As one of the most successful investigators in this branch of physiology, we might reasonably have expected Sir William Bayliss to sum up the evidence judicially, and to give us the benefit of his conclusions on doubtful points. This he does not do. He merely states all the results obtained by all the workers, and leaves the reader to pick his way among them as best he can.

(3) The late Prof. Waller's book on "The Electrical Action of the Human Heart" consists of a series of four lectures delivered by the author in 1913. The first two lectures contained a résumé of certain facts and theories based on the author's work with the capillary electrometer, and a comparison of these early results with those obtained by means of the string galvanometer of Einthoven. The remaining

two lectures are devoted to a discussion concerning the significance of certain features of the electrocardiogram.

From a historical point of view, this little book is of considerable interest; but, in a subject so young as electrocardiography, a period of ten years is sufficient to bring about considerable modification in views previously current, and the omission of references to the more recent work cannot fail to detract from the value of hypotheses based on the earlier experiments. One cannot help feeling that the views expressed are those of an advocate rather than a judge. In such small and unimportant details as the nomenclature of the different deflexions of the electrocardiogram, it is somewhat surprising that a pioneer worker in this branch of physiology should be so reluctant to adopt a phraseology which is now almost universally employed.

J. C. B.
A. D. R.

Organic Preparations.

(1) *An Advanced Laboratory Manual of Organic Chemistry*. By Dr. M. Heidelberger. Pp. 103. (New York: The Chemical Catalog Co., Inc., 1923.) 2 dollars.

(2) *Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals*. Edited by J. B. Conant, H. T. Clarke, R. Adams, and O. Kamm. Vol. 2. Pp. vii + 100. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 7*s*. 6*d*. net.

(3) *A Method for the Identification of Pure Organic Compounds by a Systematic Analytical Procedure based on Physical Properties and Chemical Reactions*. By Prof. S. P. Mulliken. Vol. 4: Containing classified descriptions of about 3700 of the more important compounds belonging to fourteen of the higher orders. Pp. vii + 238. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 30*s*. net.

(4) *Cours de chimie organique*. Par Prof. F. Swarts. Troisième édition, revue et augmentée. Pp. iii + 674. (Bruxelles: M. Lamertin; Paris: J. Hermann, 1921.) 50 francs.

(1) METHODS of preparation in organic chemistry, like all other branches of the science, tend to become out-of-date, and probably every teacher has his own list, culled from recent literature, which he gives to those students who have to bridge a gap between "preparations" and "research." Indeed, if properly chosen, supplementary preparations of the kind mentioned lend themselves admirably for the purposes of initial instruction in the methods of research, when, as sometimes happens, the research on which the advanced student is started does not involve the preparation of large quantities of initial material.

The book under review contains a number of preparations of this kind which the author has collected after many years of experience of teaching and research, and these he now offers to his fellow-teachers with an apology in his prefatory note for the fact that many of the details have been taken from his own work and that of Dr. Walter A. Jacobs, of the Rockefeller Institute. Organic chemists will, however, know that it is the first-hand information that counts, and that the author writes of a subject with which he is fully competent to deal.

The book is well printed and easy to read. The printer has evidently experienced difficulty in setting up some of the more complex formulæ, and the result is, in some cases, apt to make one dizzy, but, even thus, it is better than the easier and cheaper method of attempting to represent such formulæ in a straight line. Dr. Heidelberger has produced a useful little book for those teachers of organic chemistry who may wish to give their advanced students some more difficult preparations than those usually to be found in the ordinary laboratory manuals.

(2) This is the second volume of the series and is well up to the high standard set by the first. Twenty-five preparations are described, and all of them deal with compounds likely to be required in an organic chemical research laboratory. Each substance is treated under three headings, namely, (1) procedure, (2) notes, and (3) other methods of preparation; the method of procedure being given in sufficient detail to enable an ordinary advanced student to follow it with ease. The notes are in every case well written and give valuable and essential advice which will be of the greatest assistance to those who have to carry out the preparations. Brief but cogent criticisms are given of other methods of preparation in the sections devoted to this head, and the reasons why such methods have proved unsatisfactory in practice are clearly stated.

In every case the preparation has been carried out by one of the associated editors and checked by another, and as all four of them are organic chemists of high standing, there is no room for error. If it were possible to make this admirable compilation still more admirable, it might be done by a freer use of graphic formulæ at the heading of the chapters—they take more room, but are well worth it—and by pandering to English laziness by giving where possible the volume of solutions as well as the weight. For example, on p. 75, the expression "400 g. of 28 per cent. ammonium

hydroxide" means a calculation and therefore extra work.

(3) Looked at from the point of view of a research chemist of some thirty years' standing, the first feeling produced on reading Prof. Mulliken's volume is one of doubt as to whether the immense labour and skill expended in its compilation were really worth while; the second is a sense of disappointment that, by the exclusion of all references, an opportunity has been lost of making the treatise of real value to research workers; for it can scarcely be doubted that the work is intended for the research chemist, because who else would be interested in the vast number of compounds tabulated?

The author's "method" may, and probably does, do all that he claims, but it is scarcely conceivable that any organic chemist would use it, even if he had sufficient time at his disposal to enable him to do so. The vast majority of organic chemists, when they isolate a new compound, subject it first to an elementary analysis and then determine its empirical formula by the usual methods. They then look up the formula in Richter or in one of the many annual or decennial indexes based on empirical formulæ, as indeed they all are, and then refer to the literature. Even then identification can never be regarded as certain until direct comparison has been made. Physical properties and chemical reactions are interesting, but often misleading, and the lack of any reference to the literature prevents the chemist from doing the one thing he ought to do, that is, to prepare some of the material and compare it with that which he has obtained. In the event of the substance being too difficult or too expensive to prepare, there is another, though less satisfactory, method for establishing identity, and that is by preparing some crystalline derivative and comparing this with the same derivative prepared from the standard. But here again the author does not help, because he mentions no derivatives. If he had given references and had described one or two typical derivatives, the book would doubtless have been larger, but it would have been infinitely more useful.

(4) The book before us is the third edition of a work which evidently finds a considerable sale on the Continent. It is, as the author says, "un cours" and not "un traité," and does not, therefore, pretend to cover the whole field of the special subject with which it deals. Nevertheless the book contains 674 pages, and it should be possible to deal with most of the more important aspects of the science in this space. On the whole, the author has succeeded in compiling a readable book, and one which should be of great use to the student, provided he has facilities for acquiring help in the initial stages to fill the gaps which the author has left. It is, for example, unlikely that the student would obtain a working knowledge of stereoisomerism or of tautomerism from the rather meagre descriptions given in this book. Indeed the basic theoretical parts are too short and too difficult to follow. Otherwise the book is a valuable one and is well printed and set up. J. F. T.

The Composition and Examination of Volatile Oils.

The Volatile Oils. By E. Gildemeister and Fr. Hoffmann. Second edition, by E. Gildemeister. Written under the auspices of the firm of Schimmel and Co., Miltitz, near Leipzig. Authorised translation by Edward Kremers. Third volume. Pp. xx+777. (London: Longmans, Green and Co., 1922.) 32*s*. net.

WITH the volume before us the English translation of the second edition of Gildemeister and Hoffmann's "Volatile Oils" is now completed. The publication of the book has unfortunately been very materially delayed by the War, so that a period of no less than nine years has elapsed since the appearance of the first volume in 1913, and there are but few references to the results of investigations published since 1915. In the second volume the oils derived from plants belonging to a number of families were dealt with in detail; in the present work those obtained from the Rutaceæ (including, therefore, lemon, orange, and other Citrus oils), Burseraceæ (myrrh and elemi), Dipterocarpeæ (Borneo camphor oil), Myrtaceæ (myrtle, pimento, bay, clove, eucalyptus, cajuput), Umbelliferæ (caraway, dill, anise, celery, ajowan, asafetida), Ericaceæ (wintergreen), Labiatæ (lavender, sage, thyme, mint), Compositæ (chamomile, wormwood), and many other families, are considered.

The thoroughness with which the task has been attacked may be well exemplified by the monograph on lemon oil. Tables of statistics are followed by a map showing the districts of production of lemon, orange, and bergamot oils in Sicily and Calabria. The various methods of extracting the oil are then carefully described and the descriptions illustrated by a number of photographic reproductions. The properties and constituents of the oil are next exhaustively dealt with. Details of the chemical examination of the oil occupy 24 pages. No fewer than eleven methods of determining the citral present are described, and, which is most important, the objections to their use, and the results of the methods when tested in Messrs. Schimmel's laboratory, are appended.

Here and there in the work statements may be met with that are now no longer correct; thus on p. 492

carvacrol is said to be the only phenol present in Spanish oil of thyme, whereas Mastbaum has shown that the Spanish oils of *Thymus vulgaris*, *T. Zygis*, *T. hiemalis*, and *Corydothymus captatus* all contain notable proportions of thymol; in this case at least the discrepancy may be due to the length of time that has elapsed between the completion of the work and its publication. To clove oils 18 pages are devoted, and here also the description is accompanied by a map of the islands of Pemba and Zanzibar showing the distribution of the clove plantations. For the determination of the percentage of eugenol in the oil a 3 per cent. solution of sodium hydroxide is recommended, whereas in the "British Pharmacopœia" a 5 per cent. solution (of potassium hydroxide) is given.

Eucalyptus oils are very fully represented, no fewer than 141 being mentioned, the great majority of them, however, being of scientific rather than economic value. The commercial oil of *E. amygdalina* is now referred to *E. amygdalina*, Labill., var. *Australiana*, Baker and Smith.

The task of translation, always a rather tedious one, has been admirably accomplished by Dr. E. Kremers, of Madison, Wis. The work is couched in excellent English, reads very easily, and shows only occasionally a somewhat literal rendering of the German original. Both paper and type are good, and clerical errors are seldom to be found.

Viewing the work as a whole, one cannot but be surprised at the mass of information which has been collected by the author, sifted in the laboratories of Messrs. Schimmel, and is now offered to the scientific world. Notwithstanding the disadvantages under which the book has been compiled, translated, and issued, it must be regarded as one of the most complete in existence on the subject. It will doubtless prove a mine of information for all workers on volatile oils, and it is difficult to see how any scientific library can be complete without it.

Low Temperature Carbonisation of Coal.

Low Temperature Carbonisation of Bituminous Coal. By A. McCulloch and N. Simpkin. Pp. xii + 248. (London: H. F. and G. Witherby, 1923.) 18*s*. net.

THE low temperature carbonisation of bituminous coal is a process which has received much attention from writers, speakers, and experimenters, and Messrs. McCulloch and Simpkin have made a useful summary of the work that has been carried out. The preface insists quite rightly upon the importance of the subject in connexion with atmospheric pollution by smoke. If commercial success can be attained "Not only will it be possible to ensure a smokeless atmosphere, but, at the same time, a considerable conservation of our coal resources will result, and the country will be provided with a home supply of fuel oil."

The constitution of coal, the history of attempts dating from Parker's "Coalite" process to solve the problems of low temperature carbonisation, the difficulties arising from the expansion of coal on heating and its low thermal conductivity, the processes connected with the names of McLaurin, Del Monte, Fischer and Gluud, Illingworth and others, the nature of coal tar and of low temperature tar in particular, are discussed in turn in the seven chapters of the work. The printing is clear, and forty-three illustrations are given, most of them useful line drawings of plant, but some of Sir George Beilby's microphotographs of coke are included.

It is very difficult to write a book of this kind judicially and critically as regards large-scale operations, unless from a first-hand experience, to which the authors do not seem to make any claim either in the preface or the text. The account of each process in existing circumstances remains to a great extent a repetition of the claims made for it, although an exception must, of course, be made of those experiments which have been made and fully described by the Fuel Research Board.

The more theoretical portions of the book make mention of many researches, apparently more than have been digested. Thus, perhaps, the most striking result obtained by Messrs. Greenwood and Hodsman in their work on "The Factors Influencing the Yield of Ammonia during Carbonisation" was that oxygen did not decompose the ammonia, but was used up in the preferential combustion of other substances. The work is referred to by the authors on p. 33, but on p. 34 they say that "the presence of oxygen is detrimental to the formation of high ammonia yields since it decomposes the ammonia produced."

On the whole, however, the book stands as a good and readable account, brought well up-to-date, of a very important side of modern experimental developments in the utilisation of coal. J. W. C.

Complex Space.

Prolegomena to Analytical Geometry in Anisotropic Euclidean Space of Three Dimensions. By Prof. E. H. Neville. Pp. xxii + 368. (Cambridge: At the University Press, 1922.) 30*s*. net.

WERE a Greek from the Academy of Plato to visit England, it would surely please him to find a title he could read without using a dictionary. Should

he persist in acquainting himself with the first chapters, he would be delighted with the precision of language and thought and with the homeliness of the contents; indeed, it may be said that the number of readers of this beautifully executed work will be a fair measure of the Greek spirit among our geometers of the present day. To barbarians it will seem to cut right across the course of modern geometry with an independence which shows itself in nomenclature and notation, in absence of references, and most of all in the limitations which the author has placed upon himself in the selection of his material. This is partly accounted for by the fact that Prof. Neville is avowedly a disciple of Mr. Russell, whose well-known aphorisms are scattered over the book, and it is scarcely to be expected that a subject written in the form which modern logic demands should develop itself along lines which appear fundamental in discovery.

The earlier part of the book is an introduction to vector analysis followed by an excellent discussion of Cartesian axes and vector frames. Perhaps it should be mentioned that "anisotropic" space does not imply any "medium" theory—Prof. Neville's words have no implications but are equivalents of the symbols of the Principia. Anisotropic space is flat space of three dimensions which does not touch the absolute in four dimensions. The second half of the book is devoted to the construction of algebraic space out of those properties of vectors and points which were suggested as significant in the earlier chapters. This is a most valuable contribution, and we confine our attention to it.

Geometers say that a circle is cut by a line of its plane at two points, real or imaginary. There are great advantages in doing so, but if asked for reasons they content themselves with explaining that this is a conventional way of talking and that imaginary "points" merely stand for certain pairs of imaginary numbers. How they stand for them is not clear. To find a logical basis one of two methods may be adopted. The first, that of von Staudt, consists of replacing the imaginary points by an equivalent real elliptic involution: any construction which has been algebraically thought out by the use of imaginaries at intermediate steps can be replaced by a more elaborate real construction which can be actually carried out by pencil on paper. This method has the beauty of being geometrically relevant.

The second plan, which is that adopted in this book, has the logical advantage of allowing the real points no special privilege. Algebraic complex space is built up from such fundamental relations as hold between vectors and vectors and between vectors and points in ordinary geometry; in other words, we remove the loose convention or postulate used by the "teacher in a hurry," and carefully devise a unique construct within which all the required operations can be carried out. This however has obvious geometrical disadvantages, as it involves an embarrassing array of relations in which we have no reason to be interested.

It may be doubted if there can be any true interpretation of a space in the modern sense which does not deal with the group of transformations for which it is the accepted field. The ordinary geometry, as introduced by Prof. Neville, involves lines, directions, distances, all accepted from experience; no such geometry can dispense with the idea of motion unless it has first laid down a series of postulates such as he dislikes. This geometry, which he repeatedly refers to as "kinematical," cannot be any more logical, and is far less vivid when all reference to motion is excluded. His original space is the field of such transformations, and as such is really trivial in the complex domain. "To use geometrical language," writes Russell, ". . . is only a convenient help to the imagination." Prof. Neville's geometry reminds us of the notorious Euclidean point when it has moved, for what help to the imagination can come from a discussion of lines perpendicular to themselves or the bizarre metrical geometry of the isotropic plane? Just as the logician objects to Staudt's method as a search for complex space within real space, we fear most geometers will not pleasantly accept the task of picking out projective properties from the mass of metrical relations which Prof. Neville's method imposes on them.

George Westinghouse.

A Life of George Westinghouse. By Dr. Henry G. Prout. (For a Committee of the American Society of Mechanical Engineers.) Pp. xiii + 375. (London: Benn Bros. Ltd., 1922.) 18*s.* net.

THE American Society of Mechanical Engineers has undertaken to issue volumes devoted to the lives of some of its great men; and the supervision of the work has been entrusted to a committee of the Society. The first book of the series was a special edition of the autobiography of John Fritz, honorary member and past president. The present volume is the second of the series.

In the almost complete absence of personal records, letters, notes, and other material from which a biography could be prepared, the committee has had to draw upon the memories and impressions of those men still living who were nearest to Westinghouse, and the editor's duty has been to co-ordinate their contributions. This method of preparing a biography has both its

advantages and disadvantages; for while it helps towards the forming of a reasonable perspective, the result is rarely of any great literary interest. Such an interest, although of secondary significance during the man's generation, is a considerable asset to the perpetuation of his memory.

The genius of George Westinghouse is expressed in patent specifications and in industrial processes and products. On account of the diversity of these activities the editor has considered that a chronological survey would be confusing, and the record of achievements is dealt with under the different subjects to which they apply; in this manner an admirable summary is presented of the work of Westinghouse and its value in the world of industry.

The two major achievements made by Westinghouse were the development of the air-brake, which greatly influenced railway transport, and the application of alternating currents in the production and distribution of power. In the former he acted primarily as an inventor, in the latter as an industrial organiser. Both activities resulted in the evolution of industrial concerns, vast in size and ramifying in many directions. At the present time some seventy of these concerns exist. In other fields, he developed the use of natural gas at Pittsburgh and took out thirty-eight patents in this connexion; he did important work both in steam engineering and railway signalling, and in forty-eight years he took out some four hundred patents.

Whether Westinghouse was greater as an inventor or as a manufacturer is debatable, but both his inventions and his industrial ventures would have suffered much without this unique combination of capacities.

The greater part of the book deals with a survey of technical and manufacturing achievements, but the two concluding chapters give a well-drawn portrait of Westinghouse—the man. The editor shows him to be a man possessing almost superhuman qualities linked with very human weaknesses, a man of impelling personality, an idealist whose feet were firmly planted on the ground, a genius in imagination and vision, with marvellous powers for concentration, persistence, audacity, and fortitude to carry the fruits of his genius to such conclusions that they enormously benefited mankind. Perhaps the greatest weakness that is evident from the editor's presentation is a too great self-reliance and an inflexibility of mind when once a decision had been made. A most outstanding characteristic was his capacity for leadership, and his relations with his men were inspired by a man-to-man comradeship and good feeling, an instinct which has become traditionally known in industry as "the Westinghouse Spirit," which in its essence embodies in the highest degree loyalty and enthusiasm.

Aristotle and Physical Science.

(1) *Aristotle: on Coming-to-Be and Passing-Away.* (De Generatione et Corruptione.) A Revised Text, with Introduction and Commentary by Harold H. Joachim. Pp. xl+303. (Oxford: Clarendon Press; London: Oxford University Press, 1922.) 32*s*. net.

(2) *The Works of Aristotle: Translated into English. Meteorologica.* By E. W. Webster. Pp. vi+140. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 7*s*. 6*d*. net.

(1) THE treatise "On Coming-to-Be and Passing-Away" is one of very great interest to the pure Aristotelian. The question discussed in it is this: the four most elementary substances known to us being earth, air, fire, and water, how do these change into one another and how do they form less simple substances such as flesh and bone? For example, what happens when water is boiled in a kettle? To such questions as this the Atomists had already given an approximately correct answer. The scientific man will naturally ask whether Aristotle made any real advance on his predecessors; if he did not, why should we trouble ourselves about his views on such problems? It must be regretfully admitted that he did not make any such advance.

Aristotle seems to have been a good deal impressed by the atomic solution, but refused to accept it, criticising it with some severity, as indeed he always does criticise with severity all his forerunners. But what better had he to offer? Matter, says he, is one substratum underlying all phenomena: so far perhaps we agree with him, since modern science more and more tends towards belief in one substratum, and the weak point of the old Atomists was that they preferred a multitude of different groups of absolutely primitive matter, as Dalton did. Again, this substratum assumes the forms of the four so-called elements (which are not, strictly speaking, "elements" for Aristotle). Now if this could be interpreted to mean that the substratum appears in the four forms of solid, liquid, gaseous, incandescent, it would be very good sense, but unluckily Aristotle never put it that way. No, they are somehow formed by combinations of the two pairs of contraries, hot and cold, dry and moist: when water is boiled, the cold-moist is transformed into the hot-moist; and the efficient cause of these combinations and transformations is the movement of the heavens, in particular of the sun. Certainly the scientific man will be tempted to wish with Bacon that Democritus had come down to us instead of Aristotle—at least so far as this question is concerned.

But the pure Aristotelian does not fret himself over such considerations. His one aim is to understand the

meaning of his master and to delight in the subtleties of that astonishing world of close-packed thought, microscopic and yet universal. He will, like Prof. Joachim, find this treatise "fascinating and masterly," and he will give thanks unstinted to him for his superb exposition of it. Only those who have wrestled with the prodigious difficulties of such a work for themselves can appreciate the learning and mastery shown by him on every page of his commentary. The text also is very greatly improved: it is something of a shock to learn how untrustworthy is that of Bekker which we have been in the habit of accepting without demur.

(2) This miscellaneous work discusses various phenomena of the heavens (such as clouds, comets, the rainbow), the nature of the sea, earthquakes, wind, thunder, many properties of "composite bodies" such as iron, wood, honey, and plenty of other things besides. The admirer of Aristotle's biological works will be sorely disappointed by it; here are none of the flashes of insight and the grand generalisations which astonish us in those works, but here are his vices to be seen in abundance, especially the almost total absence of experiment, and the failure to test his hypotheses, the need for doing which he might have learnt from Socrates. One soon becomes weary of reading one facile explanation after another, almost always on wrong lines: for example, the Milky Way is "a fringe attaching to the greatest circle and due to the matter secreted." At the same time, it is of some interest, as testifying to the universality of its author's outlook on the world; "the number of things that man spied into," said Goethe of Aristotle, "is beyond belief." Perhaps the most interesting observation is that "we have only met with two instances of a moon rainbow in more than fifty years," which shows how Aristotle kept his eyes open; how many of us have seen two of them? But it is not given to any one man to be supreme alike in biology and physics.

The translation is excellently done, and Webster's early death—he was killed in battle in 1917—is a sad loss to scholarship.

A Survey of Scientific Literature.

Statistical Bibliography in Relation to the Growth of Modern Civilization: Two Lectures delivered in the University of Cambridge in May 1922. By E. Wyndham Hulme. Pp. 44 + 5 Tables + 4 charts. (London: Grafton and Co., 1923.) 6*s*. net.

THIS book contains two out of the four lectures delivered by Mr. Wyndham Hulme as Sandars reader in bibliography at the University of Cambridge in May 1922, and forms a notable contribution to the science of bibliography. Mr. Hulme's thesis is the need of co-operative action in bibliography, and in these lectures he urges as an example of this need the importance of bibliographical data as an aid to the illustration and interpretation of changes in the progress of modern civilisation.

The growth of scientific literature as a measure of man's activity has not been generally recognised—though the records previous to the nineteenth century are as a rule much more full and trustworthy than the ordinary data of the statistician—and Mr. Hulme here shows by means of graphs and tables how bibliographical statistics may not only serve to confirm conclusions already reached from other sources, but may also aid us to define and explain more precisely important movements of our social and industrial history. He takes as an example the International Catalogue of Scientific Literature as being fairly representative of the world's scientific literary output, and has compiled statistics for the years 1901 to 1913 for each of the 17 sections into which that work is divided, and correlated these with statistics of patents for invention, trade, population, etc. The figures given from the International Catalogue admittedly cannot be taken as final, for they are not only themselves subject to many adjustments, but they are also confined to the literature of pure science, and any influence that may have been exerted by advances in technology is obscured. Moreover, each branch of science is treated as a whole, and the behaviour of the various subclasses within each branch and their interrelation cannot therefore be studied. Nevertheless, the figures show certain features which would probably not be greatly modified by a more detailed examination. There is, for example, an undoubted indication of the rhythmic progress of a science, which appears to proceed in alternate periods of growth and stagnation and rises to a period of maximum output which in some cases it may be possible to predict. The year 1910 seems to have been a peak year, for there is evidence of a general falling off in all sections of the Catalogue and in patents after that year, but unfortunately the confusion arising from the War has so vitiated all statistics for years later than 1913 that it is impossible to check the extent and the duration of this depression.

Another surprising feature to which Mr. Hulme directs attention is shown in the geographical distribution of the journals indexed in the Catalogue throughout the period 1901–13. The figure for Germany and Austria is only just less than those for France, Russia, the United States, and Great Britain combined, while these four countries follow in the order given, with Russia appreciably higher than the United States or Great Britain.

In connexion with the English patent statistics which

Mr. Hulme gives from 1561 to date, the introduction of the patent specification about 1730 is an important landmark which should not be overlooked. Its need arose out of the increasing specialisation in industry—itself a sure indication of the commencement of industrial growth—and its establishment as a permanent part of patent practice so long after the introduction of the patent system is a parallel to the long time-lag that existed up to the eighteenth century between actual practice and its corresponding literature. This time-lag and the early divorce of industry from literature are well shown by Mr. Hulme in two interesting "tabular surveys" of the literature of architecture and the textile industries which give the earliest printed monograph in the different subdivisions of these two subjects, and in themselves form valuable bibliographical charts.

It is, however, more with the method advocated than with the conclusions drawn by Mr. Hulme—important and interesting as these are—that we are here concerned, and it is to be hoped that both bibliographers and statisticians will realise the utility of this new apparatus which may not unworthily play its part in the elucidation of many problems.

Our Bookshelf.

Catalysis in Organic Chemistry. By Paul Sabatier. Translated by Prof. E. Emmet Reid. Pp. xxiv+406. (London: The Library Press, Ltd., 1923.) 25*s*. net.

PROF. SABATIER'S book, of which an American translation is now issued, has been written on a basis which is considerably broader than the brilliant researches with which the name of the author is universally associated, and is very far from being a mere résumé in book-form of those researches, valuable as that would be. It is also more than a mere text-book for the instruction of students, since, instead of giving merely a few illustrative examples of particular types of chemical change, the author has usually enumerated all the most important examples, with references to the original literature in which they are described. The result has been to produce a monograph of remarkable completeness, in which the references alone would cover many pages, since they are several thousands in number.

The translation has been well done, although English readers will be amused to see on p. 25 a sentence which ends in a hyphen as a result of a refusal to repeat the second half of a name, which has already been printed on the preceding line. The pagination of the book is also very confusing, since, in opposition to all English precedents, the outer corners are occupied by paragraph numbers, the page-numbers being relegated to the inner corners, until the index is reached, when they revert to the usual position, thus giving the impression that 969 and 350 are consecutive pages. A very full author-index and subject-index have been added by the translator, in which again a novel system has been adopted, since all the references are to paragraphs and not to pages.

The American translation contains a supplementary section of 12 pages by Prof. Bancroft on "Theories of Contact Catalysis," and a number of signed footnotes by American workers. A biography, covering two pages only, is of very real value in directing attention to the range of Prof. Sabatier's researches, since his earlier work in inorganic chemistry has been largely overshadowed by the brilliancy of his later work in organic chemistry. It is also of interest to read that in 1907 he declined an invitation to follow Moissan at the Sorbonne, preferring to retain the chair of chemistry at Toulouse, which he has now occupied for nearly forty years.

The Wheelwright's Shop. By George Sturt ("George Bourne"). Pp. xii+236+8 plates. (Cambridge: At the University Press, 1923.) 12*s*. 6*d*. net.

THE title of this book gives no indication of the enjoyable nature of its contents. The author transports us into rural England as it was before the hand craftsman had disappeared before the march of machinery, and lets us into the secret of how these men found their working lives to be worth living. The knowledge which comes to the man who has to get out his own timber by the use of hand tools, and the intimate acquaintance with its peculiarities so acquired, are possessed by few workmen to-day. The book is very human, and is diversified throughout by quaint touches which throw a flood of light on the development of village life in England. Such a book could not be written except by one who had lived among the things described, and was intimately acquainted with the people. The wheelwright's shop still exists in Farnham, although it has moved with the times; its first records date back to 1706, and it came into the possession of the author's grandfather in 1810 and remained in the family until 1920.

The reader will learn a great deal more than how waggons and carts used to be built. "In the slow transition from village or provincial industry to city or cosmopolitan industry, one sees a change comparable to the geologic changes that are still altering the face of the earth. Already, during the eighties and nineties of last century, work was growing less interesting to the workman, although far more sure in its results. Whereas heretofore the villager had been grappling adventurously and as a colonist pioneer with the materials of his own neighbourhood, other materials to supersede the old ones were now arriving from multitudinous wage-earners in touch with no neighbourhood at all, but in the pay of capitalists. So the face of the country was being changed bit by bit . . . village life was dying out; intelligent interest in the country-side was being lost. . . . Seen in detail the changes seemed so trumpery and in most cases such real improvements. That they were upsetting old forms of skill—producing a population of wage-slaves in place of a nation of self-supporting workmen—occurred to nobody." The book can be recommended thoroughly to all who wish to extend their knowledge of their fellow men and who are interested in modern welfare problems.

Physics in Industry. Lectures delivered before the Institute of Physics by Prof. A. Barr, Sir James Ewing, and C. C. Paterson. (Oxford Technical Publications.) Vol. 1. Pp. 59. (London: H. Frowde and Hodder and Stoughton, 1923.) 2*s.* 6*d.* net.

THE first of these three lectures directs attention to the great complexity of the problems with which the engineer has to deal; and to the fact that, in many problems of design it is practically impossible to proceed by the method of scientific experiment; "his own experience and his inheritance of the accumulated results of the labours of his predecessors" must largely guide the successful engineer. Sir James Ewing deals with the relation of the physicist to the developmental history of the heat engine, and states that "the impulses towards any new departure are, in general, given by men who are at home in that delightful country which may be described as the borderland of physics and engineering. I have roamed in it for many happy years, and have been privileged to know some of the great men who have dwelt on its hill-tops. I have enjoyed its morning mists and its changing landscapes." The third lecture gives the experiences and views of a research physicist, working with an important electrical company which manufactures most of the machines, apparatus, and accessories made use of in modern electrical practice. His views on the duties and methods of the research organisation of such a company are of the highest importance, and should receive very close consideration by all who are interested in industrial research.

(1) *Essentials of Modern Physics.* By C. E. Dull. Pp. xi+525. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1923.) 5*s.*
(2) *The Elements of Applied Physics.* By Prof. A. W. Smith. Pp. xiv+483. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 12*s.* 6*d.*
(3) *Practical Heat.* Edited by T. Croft. (Power Plant Series.) Pp. xiii+713. (New York and London: McGraw-Hill Book Co. Inc., 1923.) 25*s.*

IN our issue of December 9, 1922, p. 792, we directed attention to the first of a series of reports on the teaching of physics in the United States by a committee of the American Physical Society formed to investigate the subject and to make recommendations for the future. The three books under notice may be regarded as outcomes of that report, for their aim is to provide a sound knowledge of the fundamental principles of the subject and to show how those principles find their applications in the common experiences of everyday life. The first is for secondary school use and introduces each principle by a familiar fact depending on it, the second supplies the needs of a student in his first year at a University intending to become an engineer, while the third is a more complete exposition of the principles which underlie heat engineering. All are well printed, and the latter is abundantly illustrated. There are a few lapses on fundamental points, but they do not seriously interfere with the usefulness of the books for those who wish to know the "why" of things they see around them.

Plane Geometry: An Account of the More Elementary Properties of the Conic Sections, treated by the Methods of Co-ordinate Geometry, and of Modern Projective Geometry, with Applications to Practical Drawing. By L. B. Benny. Pp. vii+336. (London: Blackie and Son, Ltd., 1922.) 10*s.* 6*d.* net.

ON the whole, Mr. Benny's book is one that we would heartily recommend to the class of students he had in mind while writing it. It is not a book for beginners; it is not a book for mathematical specialists. But for the student who wishes to acquire a fairly competent knowledge of the methods of analytical conics, combined with the modern geometrical point of view, the book should prove very useful. The style is attractive, and the treatment interesting.

Mr. Benny's aim is clearly to combine the geometrical with the analytical treatment of conics. This aim is one that all should approve. The only fault we can find with the author's treatment is one that he himself mentions in the preface, namely, that there is a sort of see-saw between geometry and analysis in alternate chapters. This gives a rather unpleasant impression, and we must confess that when we first took up Mr. Benny's book the impression it made was a bad one. But continued study of the book showed that the fault is more apparent than real. Perhaps in a future edition Mr. Benny could so rearrange the material as to work the geometrical and the analytical into a really organic whole. S. B.

Electrical Engineering Laboratory Experiments. By Prof. C. W. Ricker and C. E. Tucker. Pp. xiv+310. (London: McGraw-Hill Publishing Co., Ltd., 1922.) 11*s.* 3*d.*

A STUDENT in an electrical engineering laboratory should be taught to rely on his own resources and encouraged to exert his own initiative. At the beginning of his course it is advisable that he perform rapidly under careful supervision the fundamental testing experiments. He should then be assigned work which requires a certain amount of originality. If he shows a particular interest in any problem, he should be encouraged to make a research on it. The teacher is occasionally rewarded by finding a keen and accurate observer who has the ability to analyse his experiments and draw useful conclusions from them. In the book under notice fifty-six experiments are given ranging from the wheatstone bridge to the mercury arc rectifier and from the direct-current generator to the load characteristics of a three-phase commutator motor. The theory given of the various tests is not too lengthy and can be easily understood. The book can be commended to teachers and students.

Practical Chemistry. By Dr. L. C. Newell. Pp. viii+543. (London and Sydney: D. C. Heath and Co., n.d.) 6*s.*

DR. NEWELL'S work is not a "practical" text-book in the English sense, but an elementary text-book of chemistry along the lines now followed in America. Industrial applications are kept in the foreground, and illustrations of technical plant are numerous.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Calculation of the Atomic Weights of Isotopes.

SOME months ago, when engaged on a study of radioactive disintegration series, the results of which appeared in the October issue of the *Philosophical Magazine*, I was able to formulate simple rules from radioactive data which enabled me to calculate a list of the atomic weights of the principal isotopes of both common and radioactive elements. This list, which will be published in due course, agreed closely, although not identically, with all the experimental values of the atomic weights of the isotopes of the common elements determined up to that date (June 1923) by Aston and others. Since then, in a recent issue of NATURE (September 22, p. 449), Aston has published some further results with which my predictions agree so exactly that I feel constrained to give here a brief account of how my list was arrived at, and to state some results which have yet to be verified or disproved experimentally.

The main supposition is that there are four separate radioactive series the members of which have atomic weights given respectively by $4n+3$, $4n+2$, $4n+1$, and $4n$, where n is an integer. In the paper mentioned above I give reasons for supposing that the first of these is the actinium series, the second the uranium series, the third a hypothetical series the end-products of which may be bismuth ($a=209$) and thallium ($a=205$), and the fourth the thorium series. It is known that in the uranium and in the thorium series successive changes are principally of two kinds: a succession of α-particles, and the succession α, β, β and α; it is probable, and I assume it to be so, that in the two other series the characteristic successive changes are a succession of α-particles and the succession α, β, α, β. I next imagine that radioactivity continues below the so-called end-products of the series, the uranium and thorium series being continued by the elements of even atomic number and the two other ones by the elements of odd atomic number. There is no experimental evidence for this, nor does it matter. The point is merely that isotopes, which on radioactive evidence would be presumed stable, would be found experimentally to be the isotopes of common elements, and those presumed instable (bodies which supposedly expel β-particles, for example) would not be found. This is reasonable.

An arrangement of this kind yields a surprising amount of information, and it may be claimed that solely from radioactive evidence the following points may be deduced: (1) It is probable, but not impossible, that isotopes do not differ by more than 8 units of atomic weight; (2) only end-products of radioactive series or radio-elements emitting α-particles should be considered when a comparison is made between common and radioactive isotopes; (3) all elements are limited to two isotopes of odd atomic weight (odd isotopes), and these differ by 2 units of atomic weight only; (4) odd elements (*i.e.* elements of odd atomic number) have odd isotopes only, and, if there be two, the lighter one is likelier to be the more stable and consequently the more abundant in Nature; (5) even elements may have both even and odd isotopes, but the former should be as a rule at least twice as numerous as the latter, and an odd isotope should not be either the lightest or the heaviest of all; (6) isobares of common elements may be of even atomic weight only; (7) an element the atomic number of which is given by $4n+3$ has an isotope of atomic weight $4n+1$, and *vice versa*; and (8) an even element has always one isotope a unit of atomic weight higher than one of the isotopes of the element next below it.

Several of the above rules have already been pointed out by Aston from his results on common isotopes. They are indeed the common ground of both ordinary and radioactive isotopes. They do not apply in their entirety to the elements below nickel and cobalt. It is not to be expected that the lightest elements with their simple structure would behave exactly like the heavier ones. In addition, it is probable from atomic weight evidence and certain evidence from Aston's results that the series $4n+2$ and $4n+1$ do not run continuously below the limit of cobalt and nickel.

If the radioactive evidence were decisive in regard to which mass-numbers are unstable, and which are possible isobares, the determination by calculation of all the isotopes of all the elements would not be difficult, but this does not appear to be so. The evidence does not give a complete solution because, among other things, I have not considered possible branching in any of the series. Branching no doubt occurs according to some plan, but up to date I have not discovered what that plan is. Consequently on one or two occasions I have failed to agree entirely with Aston's experimental results. For example, my calculations give two isotopes to calcium, 44 and 40, and two to argon, 40 and 36, but they indicate that 36 is the more abundant, whereas Aston's results (and the atomic weight) contradict this.

For the elements from hydrogen to yttrium my list is identical with Aston's list, which covers this range completely, except that I say that scandium has a second isotope at 47. Zirconium has an isotope at 92 and possibly a third at 94, but no others in addition to its principal one at 90 already established by Aston. Niobium has 93 and 95, molybdenum is simple and 96. Element 43 would have 97 or 99 if either existed, but they do not. (Presumably a missing odd element is one which occurs at a place where two successive odd mass-numbers happen to be unstable.) Ruthenium has 100, 101, 102, and 104, possibly 98, but not 106. Rhodium is principally, and probably only, 103. Palladium is certainly 104, 106, and 108, not 105 but possibly 102 and 110. Silver is as given by Aston. Cadmium is 110, 111, 112, 114, with perhaps 108 and 116, but not 106. Indium is 115 only. Tin and antimony are as given by Aston. Tellurium is mainly 128 and 126, with possibly 130 and 124 but not 122. (Were it not that 128 is greater than the atomic weight of iodine I should be inclined to say that, notwithstanding its atomic weight, tellurium was mainly 128.) Iodine and cæsium are simple as given by Aston. Xenon is as given by Aston, except that I drop 126 or 124. Lanthanum and præsodymium are simple, 139 and 141 respectively. It is more probable that cerium is simple and 140 than complex and 140, 142, and 144. Barium is complex, having 134, 136, and 138 but not; if cerium be simple, 140, and it has no odd isotopes.

The rare earths are not difficult to do in spite of the uncertainty of their atomic weights. Each of the even rare earths is complex. Element 61 would have 147 and 149 if either existed; europium is 151 and 153, holmium 163 and 165, and thulium 169 and 171. In spite of their atomic weights, terbium is 159 only and lutecium only 177. Hafnium is mainly

178 and 180 with some 182, and has no odd isotopes. Tantalum is 181 and 183, tungsten 184 only, and element 75 would have 185 or 187 if they existed. Iridium appears to have 191 as well as 193; platinum has 194 and 196, possibly 192, but 198 is unlikely. Mercury is 198, 199, 200, 202, and 204 and not 201 as Aston finds, but I cannot add 197 as he thinks possible.

Gold is 197 and simple if Aston is right about mercury; otherwise it should have 199 also. Thallium is 203 and 205, lead principally 208 and 206, the former in excess. Bismuth is simple and 209. Polonium is of course 210, and the only member of element 84 with a chance (and that a very remote one) of being isolated. Thorium is simple and 232. One isotope of element 89 is too unstable ever to be isolated. Element 91 has 231 and 233, the former being probably protoactinium. Uranium, which is complex, has been discussed in my paper in the *Philosophical Magazine*.

The order of intensity of the isotopes cannot be given accurately from these considerations, but a rough sorting into major and minor isotopes is not difficult to make. Mass-numbers which belong to no atomic number are difficult to estimate. At present I feel sure of ten even ones and thirty-one odd below polonium, most of which Aston has found. All but one of the former are of the form $4n+2$, and more than three-fifths of the latter of the form $4n+1$. There appear to be at least thirty simple elements if my predictions be added to Aston's certainties. Fourteen of these have accepted atomic weights within 0·05 of a unit, and as many fall short of a unit by this amount as exceed it. I have assumed Aston's whole-number rule in all the numbers given in this letter.

After these mass-numbers had been deduced I found that the complexity of an element was apparently a simple function of the atomic number $16n$. Thus there is a *probability* that elements of atomic numbers $16n+7$, $16n+10$, and $16n+11$ are simple; that $16n+3$, $16n+5$, $16n+13$, and $16n+15$ have two isotopes; that $16n+8$ and $16n+14$ have no odd isotopes; and that $16n$, $16n+2$, and $16n+12$ have odd isotopes. If this deduction be substantiated by experimental work it should throw light on the constitution and stability of the nucleus.

A. S. RUSSELL.
Dr. Lee's Laboratory, Christ Church,
Oxford, October 3, 1923.

The Measurement of Very High Temperature.

IN 1914 Lummer [1] described some experiments on an arc burning in a gas at high pressure. His method of determining the temperature based on the increase of surface brightness of the positive crater is extremely unsatisfactory, and his figures, using his own values of surface brightness, appear to be nearly three thousand degrees too low. It seemed desirable, therefore, to repeat and extend the experiments and determine the temperature more precisely. A very accurate way of doing this would be to determine the ratio of the intensity of the light at two wave-lengths as far as possible apart, which would define the temperature if the positive crater were a complete radiator. This assumption need not be made if ratios of the intensities are determined at two different temperatures, one of which is known. Thus, for example, in the region in which Wien's law holds, if a_λ is a constant proportional to the emissivity, the intensity is given by

$$E_{\lambda T} = \frac{a_\lambda \cdot e^{-c/\lambda T}}{\lambda^5},$$

and

$$\log \frac{E_{\lambda_1 T_1} \cdot E_{\lambda_2 T_2}}{E_{\lambda_1 T_2} \cdot E_{\lambda_2 T_1}} = c\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)\left(\frac{1}{T_1} - \frac{1}{T_2}\right),$$

which determines T_2 in terms of T_1. Since a_λ, which may also contain the sensitivity of the measuring instrument, disappears from the final equation, this method is very convenient and may be made very accurate.

Two methods were used for determining the intensity, one by the use of a wedge as suggested by Prof. Merton,[2] the other making use of the photoelectric effect. The first method is more convenient in many cases; the second is probably more accurate.

The main difficulty is to make sure that one is really observing the hottest part of the crater. It is very difficult to keep the arc constant at high pressures, and obviously too low a temperature will be found if the arc shifts during the exposure so that part of the measurement is carried out on the colder parts surrounding the crater. If this has been avoided, comparison of the intensity at any two wave-lengths at atmospheric pressure and at high pressure enables the temperature at the high pressure to be calculated in terms of the known temperature of the normal arc. A check in the method is given by the constancy of the temperature found using various wave-lengths. The divergence from the mean is within the limits of experimental error.

Owing to the difficulty outlined above, observations at the same pressure do not repeat very accurately, though the highest values are fairly consistent. The following table summarises the provisional results for an arc in nitrogen:

Pressure in Atmospheres.	Temperature.
1	(4190)A
6	4680
18	6180
33	6520
80	8620

As already stated, these are minimum temperatures; and indications on one plate (10,000° at 50 atmospheres) seem to justify the suspicion that they may be considerably underestimated.

Further experiments making use of a number of improved methods are now in progress, and it is hoped shortly in a fuller publication to give more accurate values for the temperature of the crater as a function of the pressure and nature of the gas. The fact seems certain, however, that one can by this means reach temperatures in the laboratory considerably higher than the temperature at the surface of the sun.

It may be interesting to note here the strong reversal of some of the cyanogen bands shown on the plates within certain limits of pressure and temperature. The phenomenon is most noticeable between 30 and 40 atmospheres, and it should be possible to locate these limits more definitely in the course of the experiments.

I have in conclusion to acknowledge a deep debt of gratitude to Prof. Lindemann for much helpful criticism and encouragement.

I. O. GRIFFITH.
Clarendon Laboratory, Oxford,
September 22.

[1] Lummer, "Verflüssigung der Kohle und Herstellung der Sonnentemperatur." (Sammlung Vieweg.)

[2] Merton and Nicholson (Phil. Trans. Roy. Soc. A. 217). Prof. Merton kindly lent me the spectrometer and wedge which he used in his own investigations, and I take this opportunity of thanking him for the loan of the apparatus and for his assistance in initiatin me into the details of his method.

Early Greek Chemistry.

It is generally recognised that chemistry began, as the "divine [or, perhaps, "sulphurous"] art" (*θεῖα τέχνη*) in Hellenistic Egypt, in Alexandria, during the first centuries of our era. The books of its practitioners have existed as copies in most European libraries for many centuries. Those in the King's Library at Paris were mentioned by Olaus Borrichius in the seventeenth century; parts of the most important were published and translated by Hoefer early in the nineteenth century, and the whole *corpus* was published, with a translation, by Berthelot and Ruelle as the "Collection des anciens alchimistes grecs," under the auspices of the French Minister of Public Instruction, in 1887–88, in four volumes. It is not a little surprising to find such an eminent writer on cognate subjects as Reitzenstein, as a result of admittedly hasty examination of the Paris MSS., offering rather severe criticism of the work of Berthelot and Ruelle, since the text of the latter is based on the collation of existing MSS., and not merely on those of Paris. The production of it and of the translation was a work of no small difficulty, as might have been anticipated from the place of origin and date of the original. A very large number of words have no place even in such exhaustive works as Du Cange's "Lexicon."

It is, therefore, particularly gratifying to find Prof. Stéphanidès, of the University of Athens, now undertaking a revision of the text and translation of the "Collection" in many places where they are obscure. His knowledge of chemistry, the literature of alchemy, and—particularly—of modern Greek, are brought into use. Mme. Hammer-Jensen, it is true, has recently attempted in her essay, "Die älteste Alchymie," Copenhagen, 1921, to reconstruct the theories underlying the Greek alchemical MSS., and to rearrange them in order of date. But her evident lack of broad chemical knowledge, and her approach from the way of the so-called "classical" philology, have noticeably hampered her contribution.

Prof. Stéphanidès' article, published in the *Revue des études grecques*, tome 35, No. 162, Paris, 1922, a copy of which he has just sent me, is one of great interest and value. The following may be mentioned as an indication of the type of emendation which he has been able to suggest—throughout with a full appreciation of Berthelot. Many words left untranslated are now given meanings, *e.g.* *χάνδρα* = "false pearl" in modern Greek. The explanation of the obscure passage given on p. 6 (206, 8) of Stéphanidès' paper is very ingenious. Some of Berthelot and Ruelle's translations read as nonsense, but in the hands of Prof. Stéphanidès the text reveals its meaning: "de la largeur d'un petit miroir très mince" becomes "en forme très mince de *pierre specularis* [mica]." The passage given by Berthelot and Ruelle as, "Quelques-uns après cela font boir un oiseau depuis le soir jusqu'à une heure, puis ils laissent mourir de soif le petit oiseau, en le privant de boisson," etc., is completely incorrect, and should read: "Quelques-uns donnent <les perles> à avaler à une poule <afin qu'elle les garde dans le gézier> depuis le soir jusqu'à une heure, en privant l'oiseau de boisson, et puis, en le sacrifiant, on trouve les espèces <les perles> brillantes." (Improvement of pearls by the action of the gastric juice: a well-known operation in ancient technology.)

There will be some criticism of such renderings as "*νιτρέλαιον* = acide azotique," and *Σαλόνιτρον ἤγουν σκευοβότανον* as "*βότανον* pour la *σκευή*," because "les Byzantins appelaient *βοτάνη* la poudre à canon et *σκευή* le canon." *βοτάριον* puzzled Hoefer; it has become fashionable to render it "magic plant." Some obscurities are put down to assonance, and belief in "sympathy" (cf. the *κρονος* and *χρόνος* of the Stoics).

J. R. Partington.

45 Kensington Gardens Square, W.2.

The Musk Ox in Arctic Islands.

During my various arctic expeditions I have learnt a good deal about the ovibos (musk ox) from conversation with the Eskimos, and perhaps more from actual observation. Especially when we were in Melville Island (1916–17) we were in almost continuous association with the animal. It has occurred to me that what we know of the present habits and distribution of ovibos throws a light on one of the geological problems of the American arctic.

All my inquiries from the Eskimos and all the observations of our own party indicate that both herds and single animals move slowly—no faster ordinarily than strictly required by the feed. This means that in fertile arctic grass lands, herds move less than five miles a month. But—more important—we have neither observed nor heard about their crossing sea ice. We have never seen ovibos tracks more than one or two hundred yards from shore. It seems that, if they "thoughtlessly" start out upon the ice, they pause within 200 yards, look around for land, and turn in a direction where land is visible.

This means that, through observation and hearsay, I have concluded that the ovibos never cross from one island to another, either by swimming the water or by walking across ice. If this has always been their nature, we can explain their presence on several of the arctic islands only by assuming that once upon a time these islands were connected land.

Some of the arctic islands have numerous raised beaches and other indications that they have been rising rapidly in recent times—the Ringnes Islands, Borden Island, King Christian Island, and Lougheed Island. In none of these have we found any evidence that ovibos were ever present.

Since the living ovibos or remains of the dead are found, so far as I know, in all the other arctic islands, we must conclude that these islands were once upon a time connected with each other, either directly or by way of the mainland of either North America or Asia. It seems clear that the islands where ovibos have never been were at that time either separated by water channels from the land mass which later became the main part of the Canadian Archipelago, or else, and more probably, that they were then beneath the sea.

Vilhjalmur Stefansson.

New Court, Middle Temple,
London, E.C.4, September 24.

Scientific Names of Greek Derivation.

On looking through some arrears of Nature after the vacation I see, on August 18, p. 241, Dr. W. D. Matthew, in discussing the spelling of names derived from the Greek, asks if we should write "Deinosaur" or "Dinosaur"?

For the spelling it is no great matter, but it does matter for the pronunciation. For example, at one time it was customary, perhaps more or less may still be, to spell Pheidias "Phidias"; consequently, the unlovely pronunciation "Phiddias" was prevalent. So had we not better keep to Deinosaur?

Clifford Allbutt.

St. Radegund's, Cambridge,
October 10.

The Problem of Leprosy.

RECENT progress, especially as regards treatment, has paved the way for practical advances in the control of the world-old problem of leprosy, so a brief survey of the position appears to be timely. Ancient records show it has been present in Africa and India, and probably also in China, from the dawn of civilisation. It spread over Europe during the first centuries of the present era, was carried to the New World soon after its discovery, and new epidemics originated in some Oceanic islands as late as the middle of the last century. There is evidence to show that leprosy is now spreading among the Mohammedan races of tropical Central Africa.

Nearly all the countries with the highest incidence of leprosy are situated in humid hot tropical areas of Africa, Asia, and America. Heiser not long ago estimated the lepers of the world at about two millions, which recent figures indicate not to be an over-estimate, as some authorities place the number in China at one million; the 1921 census figure for India is 102,513, with at least an equal number of earlier unrecorded cases, while the rates in very extensive areas of Central Africa have recently been shown to vary between 5 and 60 per mille, and in small areas have run up even to 200 per mille. These are terrible figures when we remember that the present official Indian rate is but 0·32 per mille, in spite of lepers being seen daily in the streets of most large towns of that densely populated country; South Africa has 2248 and the West Indies 1433 known lepers, so the total number in British countries cannot well be less than 300,000. The eradication of the disease is thus a formidable task.

During the latter half of the nineteenth century a remarkable controversy raged between the supporters of the hereditary and contagious theories of origin of the disease. The hereditary view had for a time supplanted the ancient belief in its contagiousness, although the classical figures in support of the hereditary transmission of leprosy in Danielssen and Boeck's book of 1848 have long been shown by advancing knowledge to lend no valid support to that theory. The theory rapidly lost ground after the discovery of the lepra bacillus by Hansen in 1874, and is now finally discredited in favour of the age-long theory of the communicability of the disease. Jonathan Hutchinson's fish theory, also of prebacteriological origin, has had no supporters since his decease.

The precise manner in which the causative bacillus of leprosy passes from the diseased to infect the healthy is still, however, not finally proved, although there is a very general consensus of opinion that it enters through minute lesions of the skin or superficial mucous membranes, especially the nasal, and that prolonged exposure to close contact with a leper is usually necessary before infection takes place. In a series of 700 cases in which the probable source of infection was traced, house infection was shown in about 80 per cent., while in at least 30 per cent. the unfortunate victim had slept in the same bed as a leper before contracting the disease. It is also known that the nodular form is far more infective than the nerve type, owing to the extensive discharge of the lepra bacilli from the ulcerated skin and nasal lesions of the former. Children and persons not over twenty years of age are far more susceptible than those of thirty years and upwards. All these are very important points from the prophylactic side.

The three international leprosy conferences of 1897, 1909, and 1923 have all endorsed the contagiousness of the disease and the necessity of segregation in stamping out or greatly reducing it, as has been so successfully carried out in Norway, where 2833 cases in 1856 have been reduced to 140 at the present time, while during the last two decades the rate per mille has been reduced to less than one-half the former rate in Cyprus and Jamaica through similar measures, the value of which when practicable is undoubted. Unfortunately the expense of compulsory segregation is entirely prohibitive when such large numbers as those of India, China, and Central Africa have to be dealt with, while, even under the favourable conditions of Norway, as compared with backward and poor tropical countries, the time required to eradicate the disease is much prolonged by the impossibility of discovering and isolating the cases in an early stage, as long as this involved life-long separation from relatives and friends with no appreciable hope of recovery and restoration to their homes. The inevitable result is that by the time many of the patients were detected and isolated, other members of their households were already infected, though they develop the disease only after several years, on account of its prolonged incubation period.

Advances in the Treatment of Leprosy.

It is a remarkable fact that, just as the great specific remedies for malaria and amœbic dysentery, cinchona bark and ipecacuanha root respectively, were discovered centuries ago by the aboriginal South American Indians, so the one remedy of value in leprosy, chaulmoogra oil, is an old Hindoostan medicine. It was brought to the notice of European practitioners in 1853, and was shown by Ralph Hopkins of Louisiana to be able to clear up a certain proportion of incipient cases, although it only retarded the advance of typical ones, being too nauseating to allow of more effective use by the oral route.

Intramuscular injections of the oil proved to be more efficient, and in 1913 Victor G. Heiser reported 11 per cent. of apparent cures after some eighteen months of painful injections, which only a certain number of lepers will submit to. These observations led Rogers to search for a soluble preparation of the active portion of the oil more suitable for injection purposes, which he found in 1916 in the sodium salts of the different fractions of the unsaturated fatty acids of chaulmoogra and hydnocarpus oils derived from *Taraktogenos kurzii* and *Hydnocarpus wightiana*. First the lower melting-point fractions were used under the name of sodium gynocardate, while afterwards he concluded that

sodium hydnocarpate was more active than either the former or than sodium chaulmoograte. E. L. Walker and Marion Sweeney confirmed these observations and showed that these fractions had a direct lethal action on acid-fast bacilli as a class when added to cultures. This led them to suggest a direct action of the drug on the lepra bacillus *in vivo*.

As these soluble preparations were still painful and slow in their action, Rogers commenced to use them intravenously, when he observed occasional severe febrile reactions with inflammation of leprous nodules accompanied by extensive breaking up of the lepra bacilli in them, followed by gradual absorption and eventual disappearance of both the bacilli and all signs of the disease. The same worker next showed that a soluble sodium salt of the fatty acids of codliver oil, sodium morrhuate, and of soya-bean oil (sodium soyate) were also effective in leprosy, although they had no direct action on acid-fast bacilli *in vitro*. More recently, he has found an increase in the amount of lipase in the blood of treated cases, and Muir in Calcutta has shown that this ferment decreases after a severe general reaction, indicating that it has been used up during the destruction of the bacilli in the body.

Shaw-Mackenzie showed these soaps to stimulate the action of pancreatic ferment *in vitro* on fats; so Rogers has suggested that they may act through the lipase, dissolving the fatty coating of the lepra bacilli *in vivo*, much as Dryer has succeeded in doing *in vitro* in the case of the tubercle bacillus, a point of practical interest also in connexion with the use of sodium morrhuate in tuberculosis, which is still under trial. In the case of leprosy large numbers of the bacilli may be safely disintegrated by the treatment with apparent enhancement of the resisting powers of the patient's system, complete disappearance of extensive nodular leprosy having occasionally followed a very severe febrile reaction of a month or more in duration, followed by gradual clearing up of the disease during the following year without any further treatment. Moreover, K. K. Chatterji has obtained an active preparation against leprosy from mim oil, and Muir others from linseed and even from olive oil, so an immense field has been opened up for further search for possible curative products against both leprosy and tuberculosis.

In 1920 Prof. Dean and Dr. Hollmann in Honolulu made a further practical advance when they showed that ethyl ester chaulmoogrates and hydnocarpates can be successfully used by the intramuscular method in place of the more troublesome intravenous injections of the sodium salts. Similar preparations to theirs were the basis of "leprolin" issued by a German firm several years earlier and used with some success in leprosy by Engel and others.

Reports from all parts of the world now suffice to prove that an important advance has been made in the treatment of leprosy by these various researches, the less advanced cases being naturally more amenable to the treatment, and although in such a chronic disease as leprosy, with a very long incubation period, it is difficult to decide if actual cure can be brought about any more than in tuberculosis, yet a few of the earlier Calcutta cases have now remained free from active signs of the disease for from five to eight years. There is good reason, therefore, to hope some are actually cured, while there is no doubt the infectivity of the disease is removed in many of the earlier cases, with consequent decrease of possible contagions from them.

Provision for Treatment.

The practical question now arises as to how far the improved treatment can be utilised in the struggle against leprosy. The third International Leprosy Conference at Strasbourg in July last endorsed its value, and laid it down that segregated lepers should be provided with the best treatment. Only a very small percentage of the total lepers segregated in India and other British-governed countries are receiving its benefits, however, much less the vastly greater numbers of free lepers, including most of the earlier amenable cases, the infective powers of which might be largely abolished by six months' to a year's treatment. The treatment would cut short the new infections arising from them among their relatives and others living in their houses, and solve the hitherto unsurmountable problem of dealing effectively with the early cases of the disease, which it is often impracticable to segregate. It affords the only hope of a rapid diminution of leprosy in India, Central Africa, and other countries with very numerous lepers.

For this purpose, in addition to agricultural colonies for indigent and especially dangerous lepers, it will be necessary to organise out-patient leprosy clinics in connexion with as many hospitals as possible, where the weekly injections can be given, on the plan developed by E. Muir at the Tropical Disease Hospital. Here about 100 cases are under regular treatment, and much research work is being done with the view of improving further the treatment in the leprosy laboratory of the Calcutta School of Tropical Medicine. By this means it should be possible to render a large number of the earlier cases non-infective at a far lower cost than in settlements, and to produce a decline of new infections, and ultimately in the incidence of leprosy, hitherto impossible to obtain.

Unfortunately, it must in truth be admitted that the United States is doing far more for its lepers in the Philippines and Hawaii, both as regards segregation and in applying the newer treatment, than Great Britain is for her much greater number of lepers, mainly due to lack of funds, especially in India and Central Africa. During the last few months, however, a British Empire Leprosy Relief Association has been founded under the chairmanship of Lord Chelmsford, with the support of a number of leading British physicians and men of science, which will shortly attempt to raise the large sums necessary to remove this reproach from the British nation. This has become all the more imperative now that the Strasbourg Leprosy Conference has pointed out the obligation we are under to provide the best treatment for our segregated lepers. It applies equally forcibly to the free, earlier, and more curable cases, and it is to be hoped that no further time will be lost in bringing the knowledge that science has now furnished to the relief of those who are perhaps the most cruelly afflicted of the human race.

L. R.

The Geographical Position of the British Empire.[1]

By Vaughan Cornish, D.Sc.

The Position which has been occupied.

The British Empire, although situated in every continent, with shores on all the oceans, is seen to have a definite geographical position when we consider the ports of call which unite its lands and the naval stations which guard the communications. During the growth of the Empire eastward and westward from Great Britain, numerous harbours were held at different times, those retained being a selection unrivalled by the ports of any other State in commercial and strategic position.

The naval station of Bermuda, well withdrawn from aerial attack, has a central position in the great western embayment of North America intermediate between the ocean routes which connect Great Britain with Canada and the West Indies. No foreign ports flank the route between Canada and the west coast of Great Britain. At the western gateway of the South Atlantic we have excellent harbourage in the Falkland Isles. Malta, the capital of our fleet in the Mediterranean, has a commanding position at the straits which connect the eastern and western basins, and the naval station at Gibraltar helps to ensure the junction of the Home and Mediterranean Fleet and to protect the Cape route. The British army which is kept in Egypt as garrison of the Suez Canal ensures our use of this gateway so long as we can navigate the Mediterranean. If that navigation be interrupted we can still oppose the seizure of the Isthmus, for we are able to send reinforcements by way of the Red Sea. East of Egypt the British island of Perim stands in the Straits of Bab-el-Mandeb, and the garrisoned fuelling station of Aden provides the necessary port of call on the routes to Bombay and Colombo. Colombo, in the Crown Colony of Ceylon, is at the parting of the ways for Australia and the farthest parts of our Asiatic possessions, and Singapore stands at the narrow gateway of the shortest route between India and the Far East.

The Cape route to India and Australasia is improved by British ports of call in Sierra Leone, St. Helena, and Mauritius, and is more effectively dominated from British South Africa than at first appears, for although there is open sea to the south there are no useful harbours in the Antarctic continent, and on the African coasts the harbours are under British control for a thousand miles from Cape Town.

Of the six great foreign Powers, the French alone are posted on the flank of both routes between Great Britain and the Indian Ocean, and no Great Power has its home territory on that ocean. Thus the principal lands of the British Empire—Canada, the British Isles, South Africa, India, and Australasia—have good communications with one another across the Atlantic and Indian Oceans both in peace and war.

The conditions of strategic communication across the North Pacific, on the contrary, are adverse to us, owing mainly to the circumstance that we opened up British Columbia across the prairies and by the coasting voyage. Had our colonising route been across the Pacific, the Hawaiian Islands, which were first brought into touch with the Western world by the ships of the Royal Navy, would have been a British settlement and one of our first-class naval stations. As things happened, however, these islands were first needed by the Americans, and now form the essential western outpost of the United States navy. Between them and British Columbia the ocean is empty of islands, and Fanning Island, south by west of Hawaii, with the adjacent small coral islands in our possession, are no adequate substitute, even apart from overshadowing by a first-class naval station in the neighbourhood. Thus there is no good strategic communication between Australasia and Canada across the North Pacific. In this connexion it must be remembered that cousinship does not relieve the American Government from the obligations which international law imposes upon neutrals. It was not until three years after the outbreak of the War that America could offer us any facilities in the harbour of Honolulu which were not equally open to Germans. It must also be noticed that we have no control of the Panama route between New Zealand and Great Britain.

Turning to the question of communication between British Columbia and India, it is important to realise that the Pacific coasts of North America and Asia are in a direct line with one another, forming part of a Great Circle, so that there is no short cut across the ocean, as the map misleadingly suggests. Thus the course between Vancouver and Hong Kong is not only very long, but also closely flanked by the home ports of Japan, so that its security in time of war depends upon the attitude of the Japanese.

When, therefore, we differentiate the routes on which we have well-placed naval stations and recruiting bases from those dominated by the ports of some other Great Power, we see that the lands of the Empire are united by the Atlantic and Indian Oceans and strategically separated by the North Pacific. Thus the form in which the Mercator map is usually drawn by British cartographers with Canada in the upper left and Australasia in the lower right corner is a good representation of our maritime Empire, for it shows the countries as connected across the Atlantic and the Indian but not across the Pacific Ocean.

Upon this map a symmetrical distribution of our lands is revealed when a Great Circle is drawn connecting Halifax in Nova Scotia, the eastern terminal port of the Canadian Pacific Railway, with Fremantle, the western terminal port of the Australian railway system. This truly direct line is twisted on Mercator's map into the form of the letter S. The line passes through Lower Egypt close to the Suez Canal following the general direction of the Main Track of the Empire, which is the steaming route from Canada to Great Britain, and thence by the Suez Canal to India and Australia. At one end of the line lies the Canadian Dominion, and at the other Australasia, to the north the British Isles, and to the south the Union of South Africa, the chief homes of the British nation. Our

[1] From the presidential address delivered to Section E (Geography) of the British Association at Liverpool on September 13.

coloured peoples are also distributed symmetrically about the line, India being on the east, the Crown Colonies and the Protectorates of Africa on the west, so that it is the axis of symmetry of the Empire. Not far from its middle point is the Isthmus of Suez, where our direct line of sea communication is crossed by the only continuous route for the international railways which will connect our Indian and African possessions, and adjacent to the Isthmus is the central station of our airways.

Such is the form and position of the British Empire, regarded as a maritime organisation, which in fact it is.

The Empire thus mapped has an intermediate position among the commercial, national, religious, and racial communities of the world such as is occupied by no other State. The ocean routes must always be the link between the two great land areas of the world, and in the present state of land communication provide the connexion between the numerous independent systems of continental railways. The chief of these systems is based on the ports of continental Europe, of which the greatest communicate with the ocean, and therefore with other railway systems, by way of the English Channel. Thus the island of Great Britain is intermediate between the principal termini of the European railways and the other railway systems. Its harbourage is unequalled by that of any country of continental Europe, and its supply of shipbuilding material and coal exceptionally good. Thus the physical characters of the island accord with its position on the commercial map, and the metropolitan British in their intermediate position have become the chief common carriers of international commerce.

The Suez Canal, where we have the principal control, is the gateway between the railway termini of Europe, the greatest manufacturing centre of the world, and those of the monsoon region of Asia, the greatest centre of population. It is also on the shortest route between the railways of North America and India.

How far-reaching is the effect of our intermediate position is strikingly suggested by the fact that it is the British naval stations which would, if available, provide America with the best line for reinforcement of the Philippines, the Achilles heel of the Republic. The distance of Manila from the naval shipbuilding yards of the United States is almost exactly the same by Panama and Suez, but the Pacific connexion is bad, owing to the great distance between the stations of the American Navy. The relation of Port Said and Singapore to America and the Philippines is only one of many cases in which our position is intermediate between the home and colonial possessions of a white nation. Thus the important French possession of Indo-China has to be reached from France either by way of the Suez Canal where we maintain a garrison, or by rounding the Cape where we have a national recruiting base, as well as a station of the Royal Navy. The true significance of our intermediate position has, however, been generally missed owing to a one-sided interpretation of strategical geography. An intermediate station, particularly a naval station, has commonly been regarded as a blocking position, a barrier where freedom of movement can be interfered with. The historical fact is, however, that the harbours of the British Empire have also been a link between nations. In the War the British Empire was the link of the allied and associated powers, and its geographical position is unequalled for making a benevolent alliance effective or for checkmating the action of an alliance formed with a sinister purpose.

The British Empire provides in Canada the one link on the political map between the European and American divisions of the white race. Of the 1650 million people in the world, the whites number about 500 and the coloured 1150. The former are mainly grouped on the two sides of the North Atlantic Ocean; of the latter, the greater part, about 800 million, are in the monsoon region of Asia, which includes India, Indo-China, China proper, and Japan.

In tropical Australia the British, in the exercise of their discretion, have set up a barrier between the white and coloured races. The problem of Australian settlement is complicated by the circumstance that the northern coast-lands lie in the Tropics, and have a climate which makes field work very arduous to white men. It is, moreover, uncertain if British families would continue true to ancestral type in this climate. If, however, settlers from the neighbouring monsoon lands of Asia be admitted, it would be impossible to maintain a colour line between tropical and temperate Australia, and the labour of the Commonwealth would in time be done by coloured people. The Australian British are far from the main body of the white race and from Great Britain, the chief recruiting base of their own nation. On the other hand, the distance by sea between Townsville, Queensland, and the Japanese coast is no longer than the course of the coasting steamers from Fremantle to Townsville; and the other lands of monsoon Asia are even nearer than Japan.

The relations between geographical environment and national welfare indicate that the decision to erect a barrier against coloured labour in tropical Australia is best both for the white race in Australia and for the coloured people of the monsoon region of Asia. The admission of coolie labour would deteriorate the national character of the Australians, for the greatest nations are those which provide their own working class. The descendants of the Asiatic coolies would on their part have a stunted existence as a community unable to share fully in the national life of their new land, yet cut off from the main body of their own people. Far better, then, that the Asiatic coolie should remain where the family life of his descendants will be part and parcel of national life.

Neither should it be assumed that there is not room in Asia for a large addition to the population. The pressure of population in China is largely due to the undeveloped condition of mining, factories, and communications. The coal-fields are unsurpassed in the world, and iron ore is abundant; if they were worked, and factories were based upon them, the new occupations and improved market for agricultural produce would provide at home for many of those who now migrate overseas. The further development of manufacture in India would operate in the same direction. The growth of a manufacturing population in China and India would stimulate cultivation and stock-rearing in the sparsely inhabited region under Asiatic

rule which runs diagonally across the meridians from the Persian Gulf to the Amur, and includes the eastern provinces of Persia at one end and Mongolia and Manchuria at the other. This has for the most part a light rainfall, but comprises much fine prairie country and some good agricultural land, while in the more arid tracts there are many great rivers fed from snow-fields and glaciers which could be made to irrigate large areas.

Adjacent to the Indo-Chinese peninsula are the East Indies, the climate of which is suited both to Indians and Chinese, with great tracts of undeveloped land the productivity of which is attested by luxuriant forest. The sparsely peopled regions of Asia near to India, China, and Japan by land and sea, and for the most part connected with them by ties of civilisation, provide an area for the overflow from these countries which is more than twice as large as tropical Australia and British Columbia, together with California, Washington, and Oregon, the American frontier provinces of English-speaking labour.

India includes one of the most important borderlands within the Orient, that of the Mohammedan and Hindu worlds. The Punjab, with its great rivers and plain, is in such striking contrast to the mountains and plateau of Iran that we are apt to lose sight of the fact that, climatically, it more resembles the highland on the west than the rainy valley of the Ganges on the east. It is an eastern borderland of Islam, a religious world which is mainly comprised in the belt of dry country which stretches diagonally from the Atlantic shore of Morocco to the Altai Mountains. Delhi, under the Great Moghul, was an advanced capital of the Mohammedan world just within the Ganges valley, which is the headquarters of Hinduism. In this sub-imperial capital the two antagonistic civilisations are now linked to the government of Great Britain, and the age-long wars between them have ceased.

Up to the time of British predominance, India was the terminal position of continental conquerors unused to the sea, who did not develop the advantages of a salient maritime position. The ports of India lie conveniently for a long stretch of coast-land on the great gulf which forms the Indian Ocean, and now, owing to the facilities provided by British shipping, much of this coast-land has easier communication with India than with its own continental interior. Several British possessions in the parts of Africa adjacent to the Indian Ocean are in the intermediate position between the principal homelands of the black peoples and the overflowing population of India, and nowhere has the responsibility of our intermediate position called for more careful examination of the rights and interests of competing coloured races. The decision with reference to Kenya which has just been given by the Home Government recognises the main physical regions in the coloured world as political divisions of the Empire within which the established races have special rights, which it is our duty to safeguard.

From the foregoing facts it is clear that the British people, metropolitan and colonial, are in a greater degree than any other nation the doorkeepers of the world in respect of economic, strategic, and racial communications.

The Consolidation of the Position.

The consolidation of the geographical position which the British nation has won turns upon the future of colonisation within the Empire. The ratio of white to coloured people in the Empire is only about one to six. The former are mostly of British stock. The latter are of many stocks, differing physically from each other as much as from the white people, and belonging to diverse religions. Their numbers are steadily increasing under British rule. Consequently, if the Empire is to be guided by the British, the numbers of our race must also increase. There is, however, a school which considers that if our ideals of ethics and efficiency are once accepted by the coloured peoples, the racial complexion of the Empire will be unimportant, as public affairs will be regulated by our principles. This proselytising point of view does not take account of the contingency that British ideals implanted in coloured stock may receive alien development in future generations owing to biological causes. Our confidence in Western culture in general, and the British version of that culture in particular, is based more upon the power of adaptation which it has shown in our hands since the Renaissance and the era of oceanic discovery than upon any system of which we can hand over a written prescription. It is only in our own national communities, mainly composed of British stock, with minorities nearly akin, that we can be confident that British ideals will develop typically in the way of natural evolution. Therefore in our own interests and in that of the coloured races (who conflict among themselves) it is desirable to maintain the present proportion of the British stock, to whom the Empire owes the just administration of law and a progressive physical science.

We have to note that the population of Great Britain, which is now forty-three million, outnumbers the combined population of Canada, Newfoundland, South Africa, Australia, and New Zealand in the proportion of two and a half to one, and increases more rapidly than that of all these Dominions. Thus the chief source available for the British peopling of the Dominions is the metropolitan, not the colonial, population.

The number and density of the population of Canada is exceeded in the proportion of about ten to one by the white population of the United States, hence it is inevitable that there should be a large flow of people from the latter country to the Dominion. As it is essential to unanimity in the Empire that the Canadians should continue to be British in sentiment and not become pan-American, a large immigration from Great Britain is required in Canada. Moreover, the population of continental Europe outnumbers that of Great Britain in the proportion of something like ten to one, and as emigrants go to Canada from many European countries there is a further call for British immigrants to maintain the British character of the Dominion.

The co-operation of the Union of South Africa in the War only became possible after the failure of an insurrection by part of the Boers. Since the number of persons of Dutch and British stock is about equal, an influx of British colonists is required in order to ensure unanimity between South Africa and the rest of the Empire.

The population of Australia stands to that of Japan as about one to ten. The Japanese are a patriotic as well as an advanced nation, and claim equality with the white nations from patriotic motives. It is evident, therefore, that a strong reinforcement of British population is needed to maintain the doctrine of a white Australia. For the same reason New Zealand also needs emigrants, since Australasia is strategically one.

But what are the needs of Great Britain? There is a school which teaches that we should be strategically safer if we had no more people than our farms can feed, which would be about one-half of our present population; that we have passed the number which can ever be supported here in comfort; and that additions to the population would deteriorate its quality by packing the slums. The same school contends that emigration, by taking the best and leaving the worst, will produce a disgenic effect in the home country. The conclusion is that the salvation of Great Britain can only be ensured by a drastic reduction in the size of the working-class family. The strategic argument used by this school is out-of-date, as the proper plan of campaign for a combination of Powers bent on breaking up the citadel of the Empire is not naval blockade but aerial bombardment, and what the country now needs for its defence is a great development of technical industries and therefore a large population. A rural Britain would be quite unable to defend itself.

The economic argument shows too little appreciation of the permanent commercial advantage of our geographical position. As soon as the world gets again into its stride, conditions in Great Britain will improve, and thereafter each increase in the population of the world outside will provide more work in this country since our geographical position is unsurpassed for rendering economic service to other nations.

The common notion that we are packing the slums is contradicted by the census. Taking the case of the Metropolis, not only is central London less closely peopled than formerly but the five rural counties round London contain a million residents who were born in London and have spread out into the countryfied surroundings.

Neither does the census support the loose assertion that the towns are unable to replenish their population without fresh blood from the rural districts. The proportion of London residents who are London-born has steadily increased throughout the last forty years, and the birth-rate in towns is as high as in rural districts even when corrected for the effect of migration between them. Happily, also, the opinion formerly current that the townsman was deficient in morale was refuted by the War, in which our urban regiments showed a sustained valour which has seldom been surpassed in the long annals of military history.

The contention that selection for emigration will leave us only the worst, ignores the essential consideration that the best youngster for the Dominions is not necessarily the best for the Home Country. Here we need lads with sufficient business tenacity to resist the restlessness of youth quite as much as the Dominions need those who have a taste for frontier life.

The unequal distribution of men and women as between Great Britain and the Dominions limits the marriage-rate and consequently the total birth-rate of the British throughout the Empire in a way to which no other nation is equally subject. The excess of women in Great Britain cannot, however, be wholly paired in the Dominions unless the exodus of men to the United States be largely re-directed to our own lands.

Now that the limitation of the family is year by year determined more by choice and less by chance, it is important that all should know the size of family which is necessary for increase of the race. Taking account of the present age of marriage and the number of deaths before that age, I find that a general preference for the family of three would not quite maintain our numbers in Great Britain even if all migration ceased. If, therefore, the size of family be universally decided by choice the number of the race cannot be maintained, far less increased, under present conditions unless those who enter into matrimony cherish the ideal of a family of four children. Upon this, more perhaps than upon any other factor, depends the continued efficacy of the British Empire for guiding backward races, enlarging international commerce, and restricting the range of war.

The Sun and the Weather.

A RECENT article by C. G. Abbot and his colleagues of the Smithsonian Astrophysical Observatory (Washington: Proc. Nat. Acad. Sci., vol. 9, 1923, No. 6, p. 194) directs attention to a remarkable decrease in the amount of heat radiated by the sun during 1922 and the early months of 1923. This amount, the so-called "solar constant," has been well below its average value since the beginning of April 1922. No such outstanding sequence of low values has been found since the beginning of observations in 1905, and if the sun's variation influences terrestrial weather, 1922 and the early months of 1923 ought to show this influence. If the temperature of the earth's surface were determined directly by the amount of solar radiation, this long-continued deficiency would give rise to a general fall of temperature by 2° or 3° F. Owing to the complexity of the atmospheric circulation, no such simple direct response is to be expected, but we may reasonably look for anomalous weather, and in fact the winter of 1922–23 appears to have been unusually disturbed in North America. In different districts there were extremes of both heat and cold, drought and rainfall, and the authors remark that "while it is far too early in the study of the relations of solar radiation and weather to state that the extraordinary solar change caused the unusual winter weather, it does no harm to draw attention to both."

If we turn to Western Europe, we find similar disturbed conditions, especially in the north, while the Arctic Ocean has been characterised by low pressure and abnormally high temperature. The coincidence with low solar radiation may be remarked, but it is

difficult to trace any actual connexion between the two. The most that can be said at present is that both in North America and Europe the storm tracks lay for the most part rather far north. During sunspot minima, which are usually associated with low values of solar radiation (as in the present instance), a similar northward displacement of the storm tracks has been remarked, and in fact has been made use of by Huntington and Visshcr in their theory of climatic changes (Nature, vol. 111, 1923, p. 561). The solar effect, however, is difficult to trace because of the great complexities introduced by terrestrial conditions, and particularly by the movements of Arctic ice. For example, the anomalous weather of May last in the British Isles has been traced back to ice movements and variations of North Atlantic currents set on foot in 1921 and the early months of 1922 (*Meteorological Magazine*, June 1923, p. 100), that is, before the decrease of solar radiation had set in, though of course the latter may have played some part in it. It will be possible to analyse the effects of the decrease in greater detail when the volumes of the "Réseau Mondial" for 1922 and 1923 are completed, since this publication gives the deviations of temperature from normal at a large number of stations distributed over the globe.

Current Topics and Events.

The resignation of Prof. A. G. Green from the post of chief research chemist to the British Dyestuffs Corporation is followed by the announcement that Prof. W. H. Perkin has been appointed advisor to the headquarters research staff of the Corporation. This notice is reminiscent of a statement published in the *Times* of February 11, 1916, to the effect that "Prof. W. H. Perkin, F.R.S., of Oxford has been appointed to conduct the Research Department of British Dyes (Limited) and he has also accepted the Chairmanship of the advisory council of the company." Taking these two notices in conjunction, it does not appear that the recent one entails any material change in the relationship between the Waynflete professor of chemistry in the University of Oxford and the British Dyestuffs Corporation. Meanwhile the Corporation has in quick succession lost the whole-time services of Prof. Robinson, Dr. Herbert Levinstein, and Prof. Green. Moreover, in his last report to the Corporation, the chairman of the merger company intimated the directors' belief that "further economies can be effected in our research department." It will be of interest to note the attitude of the reappointed advisor towards the impending diminution in the research staff. Although the 400,000*l.* spent in research during four years is a considerable sum, yet it is probably less than the expenditure on trained chemists incurred by the pre-War forerunners of the Corporation, taking into account the much smaller capital sum at the disposal of these firms. The chemical staff of the Corporation is smaller considerably than that of any of the larger units of the Interessen Gemeinschaft. If, therefore, the Corporation is to compete successfully against its foreign rivals, further economies as regards chemists are very undesirable; for without ample technical assistance, the Corporation cannot fulfil the purpose for which it was founded with very substantial financial assistance from the Government, namely, with "the primary objects of supplying dyes and colours to those British trades which depend for their continuance on their ability to obtain them."

The "light plane" trials at Lympne have demonstrated the possibility of man-flight with 3 horse-power engine. Two aeroplanes tied in the principal test for fuel economy, with 87·5 miles to the gallon. The former had a 3½-6 h.p. engine, a speed of 55 m.p.h., and a mileage for the week of 362; the latter 5½-10 h.p., 74 m.p.h., and 775 miles, to which must be added a winning climb to 14,400 ft. The decisive value of excess power is thus shown. The cost of light planes built singly is about 500*l.*, and the competing machines were handled by the most experienced pilots in the country, while Maneyrol, perhaps the most brilliant pilot present, met with fatal accident, thus reminding us that flying still has its special risks. It would, therefore, be rash to conclude that flying is now cheap, easy, and entirely safe, but in spite of these cautions the results achieved will stimulate flying in many directions. The Director of Research indicated one of the most interesting of these in remarking that trials on light planes could be applied to geometrically similar aeroplanes of the largest size. There is a fairly satisfactory theory of similar aeroplanes, but the best type is being slowly evolved by the efforts of designers and the criticisms of pilots. What is suggested is that it is possible to investigate the relative merits of different types on the scale of the light plane at comparatively small expense, and then to apply the results to the largest aeroplanes, which have proved enormously expensive in development by direct methods.

An account of the investigation of a prehistoric flint mine at South Down, about three miles north of Chichester, was given by Major A. G. Wade at a meeting of the Prehistoric Society of East Anglia held at Burlington House on October 10. Major Wade has identified twenty-one circular depressions, averaging about 12 ft. in diameter, running along the summit of the Down in a straight line from east to west. Three of these, on excavation, proved to be mine-shafts sunk in the chalk for the purpose of extracting flint-nodules. The first shaft measured 12 ft. in diameter and 15 ft. in depth, and the second 9 ft. in diameter and 9 ft. in depth. Although no galleries were found, the first shaft was deeply undercut on one side where the miners had followed a vein of flint. In this shaft a pick made from an antler of red-deer, similar to those found at Grimes' Graves and Cissbury, indicated the method employed in mining. A large number of implements of Aurignacian type was found in the infilling of the shafts, and in the second the top-stone of a saddle quern of green sandstone. A large elongated axe is regarded

by Mr. Reginald Smith as identical with a late Acheulean form. The discovery is one of considerable interest, as the pits are in all respects comparable with those at Cissbury, while if the type of the implements is accepted as evidence of date, they support the view that both mines are of palæolithic age. The quern stone, unless it can be shown to be later than the implements, would then suggest a much earlier date for corn growing than is usually accepted. The excavations were carried out with the permission of the Duke of Richmond, by whom the implements, mollusca, and animal remains have been presented to the Brighton Museum.

THE *Publishers' Circular* for September 1 contains some suggestive remarks by Mr. T. W. MacAlpine on "Scientific Literature: the Need for Co-ordination." Their gist is that publishers, who cannot be expected to know the requirements of every branch of science, might welcome advice from a committee or committees of scientific workers such as might be appointed by the British Association. Among the points to be specially considered are form and style of treatment, degree and nature of illustrations, uniformity of nomenclature and symbols, size of page and of printed area, selection of type, division into chapters, paragraphs, etc., and the numbering of them, list of contents, and index. Though we hold the view that too much standardisation often checks improvement by hindering natural selection, still we think some steps could well be taken along the path sketched by Mr. MacAlpine. He is perhaps not aware that there already exists a committee of the British Association appointed to advise on similar matters in special reference to zoology and the allied sciences. The last report of this committee, presented at the Liverpool meeting, deals with some questions that directly concern publishers. One of these is the precise and correct dating of volumes and parts. The other, discussed at length, is "What constitutes Publication?" The answer is summarised thus: "Publication of a new systematic name is effective only when the volume, paper, or leaflet in which it appears is obtainable at a price in the way of trade by any applicant, or is distributed widely and freely to circles interested, it being always of a character suitable to the publication of such matter."

AT last Lyme Regis has a museum and the beginnings of a type collection of the fossils for which it is famed. The desirability of such a collection has been felt by some of the residents for many years, but the question of cost has blocked the way. In 1901 the late Mr. T. E. D. Philpot, a landowner at Lyme, erected a suitable building, but the Town Council did not see its way to find the necessary funds to maintain it, and the fabric stood empty and forlorn. Attempts to revise the situation were made early in 1914 and Mr. Philpot was approached in the matter, but the movement was abruptly ended by the outbreak of War. On Mr. Philpot's decease, two years ago, his representatives renewed his offer to the Town, and this time the Council was persuaded to accept the handsome gift. Fortunately, an enthusiastic palæontologist, Dr. Wyatt Wingrave, was ready to act as honorary curator and to lend his own private collection of local fossils. These, with a few from other sources, form quite a respectable nucleus around which all geologists will be glad to see the growth in Lyme itself of a collection worthy of the world-wide reputation of the place. The annual report shows what a good beginning has been made and includes the usual appeal for funds, for cases, and for gifts of specimens, all of which should be forthcoming now there is a place to put them and a curator to watch over them.

IN the September issue of *State Technology*—the journal of the Institution of Professional Civil Servants—the Act of the United States Congress of March last classifying civil servants is published in full. Its principal interest for us is the prominent position it gives to the professional and scientific civil servant. In Great Britain, the administrative heads of government departments, even when their concern is mainly with scientific or technical matters, are men with a classical or literary education and no scientific or technical knowledge, and the Institution of Professional Civil Servants has been urging for some time that members of the scientific staff of a department are as likely to make as good administrators as the men with no knowledge of the affairs of the department at present chosen. From the above Act, it appears that this is recognised in the United States, and in their civil service, professional and scientific work is administered by men with professional and scientific experience. The salary attached to the highest posts, whether professional or administrative, is 7500 dollars per annum.

A SMALL but instructive pamphlet on the co-operative development of Australia's natural resources has been published by the Commonwealth Institute of Science and Industry. The whole field of Australia's resources is briefly surveyed and attention is directed to certain urgent problems that await solution. Particularly important is the section dealing with agricultural and pastoral problems. The ravages of vegetable and animal pests are shown to be enormous. In New South Wales and Queensland alone, the total area covered by the prickly pear is not far from double the entire cultivated area of the Commonwealth. From plant diseases alone the annual loss to Australia is estimated at more than 5,000,000*l.*; animal pests are even more costly. In a bad year the sheep-fly may cause a loss of 4,000,000*l.* A long list is given of investigations needed in the interests of agricultural, pastoral, and forest industries. The pamphlet makes a strong plea for the application of scientific method and research in the development of Australia's resources. Copies may be had free of charge on application to the Director of the Institute at Melbourne.

AMONG the many new periodicals of varying aims and quality relating to wireless telegraphy and telephony, we are glad to welcome a new-comer in *Experimental Wireless*, of which the first monthly

issue is before us. This in its own words is a "Journal of Radio Research and Progress," and wisely leaving to the more popular type of paper, elementary matter, broadcasting news, and doings of societies, concentrates upon articles on recent developments and experimental research. For example, a new connexion for valve generators, in which the oscillating circuit is connected between the grid and the filament, is described in an article by E. W. Gill, and the possibilities of the neon tube both as an oscillator and a receiver are discussed by E. H. Robinson. Another suggestive article deals with the correction of distortion produced by amplification, especially in the case of loud speakers. Notable among several other important contributions is an account of investigations of the Radio Research Board on the fading of signals. Another way in which the proprietors of the journal are encouraging research work is in the maintenance of a laboratory and testing service whereby readers' apparatus can be calibrated and other electrical measurements made entirely free of charge. The journal should be an important help to workers in wireless and is entirely independent of trade interests or other wireless organisations.

DR. A. KOSSEL, the well-known physiological chemist of the University of Heidelberg, celebrated his seventieth birthday on September 16 last.

THE Fothergillian gold medal and prize of the Medical Society of London have been presented to Sir Arthur Keith, Conservator of the Museum of the Royal College of Surgeons.

THE Thomas Hawksley lecture of the Institution of Mechanical Engineers will be delivered at the institution on Friday, November 2, at 6 o'clock, by Sir Westcott S. Abell. The subject will be "The Mechanical Problems of the Safety of Life at Sea."

WE much regret to announce the death on October 10 of Dr. J. A. Harker, F.R.S., at the age of fifty-three; of Dr. A. A. Rambaut, F.R.S., Radcliffe Observer, Oxford, and late Royal Astronomer of Ireland, on October 14, at the age of sixty-four; and of the Hon. Nathaniel Charles Rothschild, on October 12, aged forty-six.

THE Council of the National Institute of Agricultural Botany has appointed Mr. A. Eastham to be Chief Officer of the Official Seed Testing Station for England and Wales. Mr. Eastham, who studied agriculture and botany at the Lancashire Agricultural School, Cheshire Agricultural College, and the University of Edinburgh, completed his training in Canada, where he specialised in agricultural botany. Previous to his return to England, Mr. Eastham held botanical and seed-testing appointments in Canada.

PROF. W. D. TREADWELL, of the Technical High School, Zürich, will lecture on "Electrometric Methods in Analytical Chemistry" on November 2, under the auspices of the Manchester sections of the Society of Chemical Industry, the Institute of Chemistry, the Society of Dyers and Colourists, and the Manchester Literary and Philosophical Society.

THE fifth of the series of public lectures on "Physics in Industry," being given under the auspices of the Institute of Physics, will deal with the subject of "Physics in the Textile Industries." It will be delivered by Dr. A. E. Oxley, physicist to the British Cotton Industries Research Association, at the Institution of Electrical Engineers, Victoria Embankment, London, on Monday, October 22, at 5.30 P.M.

THE sixth annual general meeting of the British Association of Chemists will be held at the Chemical Department, University of Birmingham, Bournbrook, on Saturday, October 27. A chemical exhibit has been arranged by Prof. G. T. Morgan, to precede the meeting. The Society's annual dinner will be held at the Queen's Hotel, Birmingham, during the evening. The president, Dr. H. Levinstein, will take the chair at both the general meeting and the dinner.

ACCORDING to a Press announcement, a "Mammoth's Shoulder Blade" has recently been landed at Douglas, Isle of Man, having been brought up in a trawl off Ramsey. The bone is supposed to be the shoulder blade of a mammoth. From the back to the end of the blade is 6 ft.; the bone is 2 ft. thick and more than 3 ft. wide. Lengthy accounts were given of the mammoth, the period in which it lived, etc. Photographs have been submitted to Mr. T. Sheppard, of the Municipal Museum, Hull, from which it is clear, as might have been expected, that the "bone" was the skull of a whale.

RECENT issues of the *Times* (September 29 and October 10) reproduce many interesting photographs of the effects of the great earthquake in Japan. They show how well some of the great public buildings in Tokyo (such as the Metropolitan Police Station and the Imperial Theatre) withstood the shock of the earthquake, though they were afterwards destroyed by fire. The magnitude of the sea-waves is represented by a photograph of a scow, or flat-bottomed ferry-boat, thrown bodily on to the quay at Yokohama. A third picture illustrates a not uncommon effect of great earthquakes, that of railway-lines left suspended in air while the bridge below has collapsed.

A GRANT of 25,000*l*. has been made by the Development Commission to the new Research Institute for the investigation of animal diseases to be erected in connexion with the Royal Veterinary College, Camden Town, London. Sir John McFadyean, principal of the College, will be the first director of the Institute.

THE report of the field work of the Smithsonian Institution for the past year describes the manifold activities of this important body. Accounts are given of no less than twenty-two expeditions organised by it and its branches; they include geological explorations in the Canadian Rockies: the use of the great 100-inch telescope at Mount Wilson Observatory in connexion with a special vacuum bolometer and galvanometer to measure the heat in the spectrum of the brighter stars: an expedition to the North Pacific Fur Seal Islands: the collection of Australian fauna for the Museum, and a similar enterprise in little-known parts of China: botanical investigation in the

Republic of Salvador and Guatemala: archæological studies at the Mesa Verde National Park, Colorado, and of totem poles in Alaska. Less generously endowed scientific institutions in Great Britain will look with envy on such enterprises, but will recognise them with full appreciation as important additions to the general stock of human knowledge.

THE Rede lecture for 1923, by Prof. H. A. Lorentz, on "Clerk Maxwell's Electromagnetic Theory" is to be issued in pamphlet form in November by the Cambridge University Press.

MESSRS. DULAU AND Co., LTD., 34 Margaret Street, W.1, have just circulated a useful catalogue (No. 105) of second-hand books on entomology, general zoology, geology, and mining. Nearly 2000 works are listed, and the prices asked appear very reasonable.

MESSRS. ERNEST BENN have in their autumn list several books of scientific interest, among which we notice "The Principles and Practice of Wireless Transmission," by Parr, in which the theory of the production and control of wireless waves is set forth in non-technical language; "Across the Great Craterland to the Congo," by A. Barns; "The Diseases of Glasshouse Plants," by Dr. W. F. Bewley, of the Cheshunt Experimental Station, giving the practical results of the experimental work of the station in recent years; "Successful Spraying," by P. J. Fryer, which is primarily intended as a handbook for the practical grower wishing to know the results of recent researches upon the subject; "An Introduction to the Study of Chinese Sculpture," by L. Ashton, which professes to be the first European book dealing with this branch of Chinese art; and "Plastic Art in China," by O. Siren, with an introduction and epigraphic notes by P. Pelliot.

PROF. W. E. DALBY is bringing out, through Messrs. Edward Arnold and Co., "Strength and Structure of Steel and other Metals," the main purpose of which is to correlate strength of metals with their structure. In this volume the subject has been considered from the point of view of the engineer, and, so far as possible, in terms readily understood by the engineer. Other books in the same publishers' announcement list are: "A Handbook of the Coniferæ and Ginkgoaceæ," by W. Dallimore and A. B. Jackson, containing descriptions in easily understood terms of all the cone-bearing trees, with information upon their economic uses and cultivation. Although the book is primarily a general work upon conifers, special attention has been given to those that are hardy in the British Isles or are of outstanding economic importance. A feature of the work is the series of keys to genera and species which are designed to assist beginners in the work of identification. "British Hymenoptera," by A. S. Buckhurst, L. N. Staniland, and G. B. Watson, with an introduction by Prof. H. Maxwell Lefroy, being an introduction to the study of the habits and life-histories of British saw-flies, wood-wasps, gall-flies, ichneumon-flies, ruby-wasps, digger-wasps, mud-wasps, wasps, bees, and ants. Information is given as to their identification, and technical terms are carefully explained.

Our Astronomical Column.

THE WANT OF SYMMETRY IN STELLAR VELOCITIES.—Proc. Nat. Acad. of Sciences, U.S.A., for September contains an article by Dr. G. Strömberg, of Mt. Wilson, on this subject. This unsymmetrical distribution was first found by B. Boss from a study of measures of parallax and radial velocities; later Adams and Joy found it independently. Stars of high speed appear to move towards the hemisphere between galactic longitudes 160° and 340° (through 250°).

Dr. Strömberg extends the research to the globular clusters and spiral nebulæ, finding that all known objects appear to show the same asymmetry; he conjectures that it may arise from the existence of a fundamental system of reference, with regard to which excessive velocities are very infrequent. The stars of moderate velocity were found to be divisible into two groups, one with a slightly eccentric velocity-ellipse in the galactic plane, the other with a more eccentric ellipse.

The stars of high velocity give an ellipse with axes parallel to the last ellipse, while the globular clusters and spiral nebulæ give circular distribution: in each case the group-motion increases *pari passu* with the internal motions. On the assumption that the spiral nebulæ have acquired the maximum attainable velocity, he calculates the position of the fundamental frame, and shows that referred to it the sun is moving with velocity 651 km./sec. towards R.A. 305°, N. Decl. 75°.

NEW TRANSIT INSTRUMENT AT PARIS.—M. B. Baillaud, director of the Paris Observatory, describes in the *Comptes rendus* of the Paris Academy of Sciences for August 7, a new transit instrument which has been erected at the Observatory for the determination of the time that is distributed by wireless signals from the Eiffel Tower. These signals are now used so widely that the question of their degree of accuracy is important to many astronomers; hence an instrument was designed of such a size that it could be reversed on every star. The object glass is by M. Viennet, and is of excellent quality; its aperture is 4 in. and focal length 48 in. The magnifying power is 60; the self-registering micrometer has two threads that travel in opposite directions at the same rate, crossing each other at the centre of the field. The threads are driven by electric motor and the rate of driving is regulated by a rheostat. The object of the two threads is to save the time required to get the star on the thread again after reversal; having been observed on one thread up to reversal, it is automatically found very close to the other after reversal. The order of positions is reversed for alternate stars.

The level error is found both by spirit levels and by nadir observations. The collimation error is at present determined on the nadir, but collimators are in course of erection.

The results of time determination are satisfactory. The figures that are printed never show a greater range for separate stars on the same night than a tenth of a second; it seldom exceeds half of this amount.

Research Items.

The Sheel-na-gig at Oaksey.—The Sheel-na-gig or phallic figure, usually found in churches, is probably the survival of a fertility cult. That at Oaksey, in North Wiltshire, is described in the September issue of *Man* by Miss M. A. Murray and Mr. A. D. Passmore. It is carved out of the same stone as that of the church, a thirteenth-century edifice, but there is nothing to show whether it is in its original position, or whether it is contemporary with, or earlier than, the church. But the size and importance of the left hand in the sculpture are noteworthy and suggest a pre-Christian origin for the figure. The flat surface of the stone has been slightly hollowed so as to make the figure stand out in relief. The weathering of the stone has practically destroyed the features, which appear to have been rudely indicated.

The Island Culture Area in America.—In the thirty-fourth annual report of the Bureau of American Ethnology, 1912–13, recently issued, Mr. J. Walter Fewkes discusses the prehistoric island culture area of America. He concludes that, from the data now in hand, it is possible to distinguish three cultural epochs in the West Indies. The earliest people were cave-dwellers, a mode of life that had not totally disappeared at the arrival of Columbus, a culture extending through both the Greater and Lesser Antilles, though, owing to the absence of caves, it naturally did not exist in the Bahamas. The absence of fine stone objects separates the West Indian cave-man from that of the following epoch, the agricultural West Indian, when stonework reached a perfection not excelled elsewhere in the two Americas. The archæological evidence of the third epoch, or that of the mixed race formed by an amalgamation of agricultural and Carib elements, appears to indicate a decline in the arts, as would naturally be expected from the nature of the life of the inhabitants. All three stages of culture—cave-man, Tainan, and Carib—coexisted when the West Indies were discovered. The first mentioned had been driven to isolated, undesirable localities; the Tainan held the Greater Antilles, but had been submerged in the Lesser except in Trinidad; the Carib occupied the islands between Trinidad and Porto Rico, and was slowly encroaching on the Greater Antilles at the coming of Columbus.

Early Arithmetical Processes.—At the recent meeting of the British Association, the Rev. C. A. Brodie-Brockwell, professor of Hebrew and Semitic languages, law, and history in McGill University, Montreal, presented to the Anthropological Section a paper dealing with the evolution of arithmetic with special reference to the principles of compound-time or reckoning. He maintained that modern scholars, through neglecting to take into account the fact that pre-Christian Mediterraneans used arithmetical processes without analogy in modern arithmetic, had obscured the meaning of ancient time determinations. He proceeded to show wherein the ancient processes differed from the modern, and suggested that owing to the fact that the ancients worked in units larger than those we employ, it was necessary to divide or subdivide according to the method of computation before the figures were comparable with modern calculations. Thus, according to the method of computation, any given figure may be divisible by two, three, or four to arrive at its modern equivalent. Prof. Brockwell concluded by demonstrating the application of his theory of compound-time to a Babylonian tablet, previously undeciphered, which was discovered by Prof. Hilprecht, to Plato's Millennium Cycle, and to Proclus' Pythmenic Indices.

Imagery in Thinking.—In *Discovery* for August, Prof. T. H. Pear gives a very lucid account of the vehicles and routes of thought. He thinks that the recent mobilisation of psychologists for practical work has led to the neglect of a problem which at first sight appears rather theoretical, but may actually have far-reaching practical results. It is well known that people vary in the way in which they think, but having classified people as visuals or audiles, there is a tendency to neglect the consequences. The writer thinks that for practical purposes people can be described as visualisers or verbalisers according as they tend to think in pictures or words. Each type of thinking has its own advantages and also its own drawbacks, and extremes of either type often fail to understand the other, not infrequently with serious consequences. Should a teacher or a doctor be too exclusively one type it might account for some failures in dealing with particular pupils or patients. The visualiser he holds is less likely to be impressed by an orator's rumbling stream of words or less easily hypnotised by a sonorous phrase or platitude, but, as against this, he may be paralysed by impressive tailoring or a pretty smile. The article is an excellent example of sound scientific thought expressed in non-technical language.

Sex Reversal in the Common Fowl.—At the recent meeting of the British Association in Liverpool, no little interest was excited by Dr. F. A. E. Crew's account of a case of complete sex-reversal in the common fowl. A hen, after laying a number of fertile eggs in a perfectly normal manner, was converted into a cock which became the father of chicks. This remarkable reversal of sex seems to have resulted from the destruction of the ovary by tubercular disease and its replacement by testes. Dr. Crew has published his observations on this and similar cases in a recent number of the Proceedings of the Royal Society (Series B, Vol. 95, No. 667) and Miss Honor B. Fell gives a more detailed account of their histological features in the first number of the *British Journal of Experimental Biology* (October).

Reproduction in *Paludestrina jenkinsi*.—It has long been suspected that the Gasteropod mollusc, *Paludestrina jenkinsi*, reproduces itself by means of parthenogenetic ova. If so, it is the only mollusc in which this phenomenon is known to occur. The probability is converted into a practical certainty by the careful breeding experiments of Mr. Guy C. Robson, described in the first number of the *British Journal of Experimental Biology* (October). No male has ever been observed and there is no evidence of hermaphroditism. This little snail is also remarkable for the curious manner in which, in the British Isles at any rate, it has extended its range in recent years from brackish estuaries to inland fresh waters, which, as Mr. Robson suggests, may have something to do with its parthenogenetic habits.

The Shape of Plant Cells.—The botanist who is under the impression that the typical shape and mode of division of a normal parenchymatous cell is fully represented by the usual text-book diagram, where such cells are always in transverse or longitudinal section, is recommended to study the paper by Mr. Frederic T. Lewis in the Proceedings of the American Academy of Arts and Sciences, Vol. 58, No. 15. The author has prepared serial microtome sections of the pith of the elder, from which outline drawings and then wax models of the cells have been prepared by standard methods. The result is to show that the cells are essentially tetrakaidecahedra,

as the mathematicians and physicists had anticipated; from the models it is possible to reconstruct the method by which this form is restored after cell division.

"Red Plant" in Strawberries.—During recent years the spread of a mysterious disease among strawberries has been reported under this name from one centre of strawberry growing after another, in some districts the strawberry growing industry being seriously threatened by its depredations. Typically diseased plants have been under observation at the Research Station, Long Ashton, Bristol, and now Messrs. E. Ballard and G. S. Peren report that the disease is only a special form of the well-known "cauliflower" disease of strawberries which has been known for some thirty years and was first discovered by Mrs. Ormerod. As in the case of the "cauliflower" disease, the causal organism in "red plant" is found to be the eelworm *Aphelenchus fragariæ* Ritz. Bos, a conclusion which, as recent correspondence in the *Gardeners' Chronicle* witnesses, is in agreement with that of other practical observers familiar with the disease. "Red plant" appears to be an unfortunate name for the disease, as it is only when the eelworm attack synchronises with a certain stage of development in some varieties of strawberry that the striking red colour develops in the petiole and lamina of the ill-developed leaves.

Control of Finger-and-toe by Liming.—In Bull. No. 29 of the North of Scotland College of Agriculture, Prof. Hendrick describes an experiment carried on for several years at Craibstone under conditions particularly conducive to the spread of finger-and-toe disease. The soil is sour and very poor in quality, and turnips have been grown on the same land since 1915; mass infection has been induced by leaving plenty of diseased material upon the plots, and manures favourable to the increase of the disease have been systematically applied. Although disease occurs yearly on the limed plots as well as on the unlimed, in the former case a large proportion of the roots are fit for use, even though touched by disease, whereas in the latter case most of the roots are rotten and unusable. It would seem that though a cure is not effected, some measure of control can be exercised by adequate applications of lime, in moderate excess, but in each individual case it will be necessary to balance the cost of the liming against the improved value of the crop, in order to determine whether the procedure is economic and advisable.

Inaudible Air-waves.—The current number of *Science Progress* (pp. 294-297) contains an article by Dr. C. Davison on inaudible air-waves resulting from explosions. These waves are manifested chiefly by the rattling of windows, the disturbance of pheasants, and the traces of barographs. Such effects are noticed far beyond the area within which the sound of the explosion is audible. For example, the firing during the Dogger Bank action of January 24, 1915, was heard in England to a distance of 208 miles, while pheasants were disturbed near Workington (320 miles). The velocity of the inaudible air-waves is slightly less than that of sound, but, when a silent zone is developed, the sound-waves, which at first outrun the inaudible waves, in the outer sound-area follow them after a brief interval. As windows are shaken and pheasants are disturbed in the silent zone, it is suggested that the inaudible air-waves cross the silent zone close to the ground while the sound-waves travel at a somewhat greater elevation.

Industrial Water Supply in the United States.—An inquiry into the nature and source of the water used in industrial establishments in the United States has led to some interesting results. These are published in Water Supply Paper No. 496 of the United States Geological Survey. The census of 1920 showed that 35·7 per cent. of the total population lived in 287 places each of more than 25,000 inhabitants. Analyses of the water supply of these 287 places and, in addition, of many smaller places, are given so that each state is represented by at least two cities. These details deal with the bulk of the water used for industrial purposes even if they show the character of the water used by less than half the total population. Many of the analyses are the work of the Geological Survey; others have been obtained from municipal, state, waterworks, and commercial laboratories. Of the 307 cities quoted in the report the great majority has surface water but a few have ground water. A sketch map shows the average distribution of hardness. This quality, due to calcium and magnesium salts, is practically the only one of much industrial importance. The figures show that of the 39,000,000 persons served with the waters analysed, about 17,000,000 use water with less than 55 parts per million of hardness, 6,000,000 use water with 55 to 100 parts per million, and most of the remainder use water with 100 to 200 parts of hardness per million. The pamphlet contains also a discussion of the treatment of water for public supplies.

The Determination of Sea-level.—In an article in *Science Progress* for October on the levels of land and sea, Sir Charles Close discusses the problem of arriving at the mean level of the sea as the datum to which height on the Ordnance Survey maps of Great Britain are referred. What is required is the mean position of the sea surface as determined over a considerable period of time, at all states of the tide, and not merely at high and low water. The most satisfactory way of arriving at this mean is by the use of self-recording tide-gauges. In practice the mean of the hourly tides measured over a long period will give the result desired. For this purpose tidal stations were set up at Dunbar in 1913, Newlyn in 1915, and Felixstowe in 1917, and are still at work. Each of the two stations of longest duration show a range in height of the annual mean sea-level of 2·3 inches. Hence it is obvious that the value of mean sea-level cannot be obtained during the period of a year. At other stations in the British Isles and elsewhere, annual fluctuations have been noted. In fact the probable variation of height of any one year from the mean of a large number of years is about half an inch. The most important variations are meteorological and are in part local, in part world-wide. Of smaller significance are the latitude variation tide with a period of 431 days and the lunar tides of 18·6 years.

Sunspots and Air Temperature in America.—The *Monthly Weather Review* for May contains an article on sunspots and terrestrial temperature in the United States based upon a communication to the American Meteorological Society by Mr. A. J. Henry of the U.S. Weather Bureau. It is pointed out that annual deviations of temperature give evidence of short period variations within the 11-year sunspot cycle. Sometimes warm and cold years alternate; in other cases the cycle, cold to warm, would be completed in three, four, or five years. During the period 1870–1921, a heat maximum corresponds fairly well with a maximum of sunspots and *vice versa*. Prior to that period the agreement is not so good. The author mentions that until some allowance can be satisfactorily made for the movement of cyclones and anticyclones, it is hopeless to seek for effects of changes

in the intensity of solar radiation in the temperate zone. Observations are used for as many stations as practicable in the United States, and in using the published means of temperature derived from the daily extremes, appropriate corrections have been applied to reduce to true means. Temperatures dealt with range between the years 1750 and 1921, but the number of stations are very few prior to 1825. Summarising the conclusions and results of various authorities on the subject, the author states that it appears that the weight of evidence is in favour of the existence of a variation in the air temperature of the globe corresponding roughly with that of the spottedness of the sun, an increase in spots corresponding with diminished terrestrial temperature and *vice versa*. The effect is best shown in the tropics and is difficult to trace in temperate latitudes. There were three pronounced maxima and minima of temperature between 1873 and 1921, the maxima occurring in 1878, 1900, and 1921, and minima in 1875, 1893, and 1917.

BOMBAY MAGNETIC CURVES.—We have received from the Director of the Government Observatory, Bombay, a collection of photographic copies of Bombay magnetic curves for selected disturbed days during the years 1906 to 1915. Records are included from several hundred days, covering about 150 large sheets. Magnetic disturbance at Bombay is seldom large except in H, the intensity of the horizontal component. The curves reproduced are mostly for this element, but the declination and vertical force curves are also reproduced for some of the storms. The times, and the base line and scale values, are clearly shown in every case, and the reproductions are excellent; thus much valuable information is deducible as to the character of magnetic disturbance in Bombay. As compared with curves from European or North American stations, the Bombay curves are comparatively free from rapid oscillations. Some of the curves, however, are decidedly lively, including those for February 9-10, 1907, September 12-13, 1908, May 14-15, 1909, September 25, 1909 (when there was considerable loss of trace), and June 17, 1915. There are many examples of "sudden commencements" of magnetic storms, all or nearly all exhibiting the characteristic rapid rise of horizontal force. In some cases this increase of force persists for a number of hours, the curve having a crested appearance; in other cases a fall to less than the normal value follows hard on the initial rise. The weight of the volumes of collected curves is considerable, and the Director of Bombay Observatory expresses his regret that owing to the heavy postage, and the necessity for economy, he has been obliged to restrict the issue. He would be glad, however, on receipt of the postage, to send a copy to any magnetician who would like to have one.

COCONUT OIL.—The coconut oil industry is surveyed in the *Chemical Trade Journal* for September 7. This substance is known to us as a fat; only in warmer climates is it an oil. It is obtained from the kernels of the fruit of the coconut palm, which flourishes in India, Ceylon, and other tropical countries. The first importations into Europe occurred in 1815; they have since steadily increased. The article contains brief accounts of the properties (physical constants, etc.), composition, and manufacture of the oil. The bulk of the oil is used in the soap and candle industry. Future prospects are discussed.

A DIRECT READING X-RAY SPECTROMETER.—In 1915 Duane and Hunt found that a spectrum of general X-rays is terminated sharply at the short wave end, the boundary wave-length being precisely connected by Planck's quantum relation with the maximum voltage applied to the X-ray bulb. The output of general X-rays is roughly proportional to the square of the voltage, and provided the peak-voltage is the same, the energy-distribution curve of the X-ray spectrum is found not to vary markedly with the shape of the wave-form of the exciting potentials which obtain in practice, whether from coil or transformer. For medical purposes, at any rate, it is sufficient to assume that in the absence of a filter the general quality of the rays is independent of the means by which the X-rays are generated but is determined only by the position of the quantum limit. Drs. Staunig, March, and Fritz, of Innsbruck, have designed a convenient type of X-ray spectrometer for measuring this boundary wave-length. In this instrument (the English agents for which are Messrs. Schall and Son, 71 New Cavendish Street, W.1) a narrow slit of X-rays passes through a thin plate of rock salt crystal and the deviated beam is observed visually as a narrow band on a fluorescent screen provided with a scale of wave-lengths. The crystal is capable of rotation, and the observations consist essentially in measuring the minimum deviation between the reflected beam and the undeflected beam. In practice it is convenient to ascertain both the right-hand and left-hand positions of the deflected beam and halve their angular separation, thus avoiding a determination of the zero position. It is important that the observations should be made in a darkened room by an eye thoroughly adapted to darkness. The spectrometer, which should be earthed, is brought as near the X-ray tube as possible, the protection for the operator being afforded by sheet lead. As will be gathered, the instrument is also capable of being used as a means of measuring peak-voltage.

TEMPERATURE OF THE CROOKES DARK SPACE IN GLOW DISCHARGE.—Herr R. Seeliger, in the issue of the *Zeitschrift für Physik* of June 29, contests the opinion recently expressed by Günther-Schulze that the temperature in the dark space of the glow discharge is high (NATURE, October 13, p. 557). The canal ray particles are in part neutral, and do not behave like elastic spheres to which the geometrical laws of mechanical collision can be applied. When collisions take place in which the charge is altered, the changes of velocity and of direction are small; when the colliding particles are absorbed, this takes place without previous appreciable loss of velocity. It is only for the first type of collision that the free path is of the same order as the molecular free path; for the second it is very much greater. For ionic velocities, with high or "anomalous" cathode drop, these properties of the canal rays can probably be directly applied to the glow discharge; for smaller values, corresponding to normal cathode drop, similar complete observational results are not available. Certain qualitative observations (*e.g.* those of Dempster) point to the fact that things are essentially the same in both cases; and observations made so far on canal rays (+ions) do not suggest the existence of the difficulties raised by Günther-Schulze; but seem rather to be in agreement with the results obtained by him as to energy relations and distribution of velocity, without assuming a high temperature in the dark space. All direct measurements of the temperatures of the cathode, and of the dark space, have shown that these are only a little higher than that of the surroundings, not much more than 100° C., although in special cases the temperature of the cathode can be raised to the melting, or even the vaporisation, point.

A Library List of Scientific Books.

ABOUT two years ago the Washington Academy of Sciences published a list of one hundred popular books in science suitable for inclusion in public libraries. The list has since been revised, and is reprinted below. The original list included the titles of forty-three books by British authors, but many of these have now been omitted as the volumes are out of print. All the works in the present list are obtainable through booksellers in the usual way. As the list was compiled for American libraries, the majority of the books mentioned in it are by American authors. We know of no similar list for British libraries, but one would no doubt be welcomed by librarians and others. Though librarians may be able to discover which books are interesting, they have no easy way of finding out which of such books are trustworthy and which are not merely unorthodox but misleading or misinforming.

In inviting correspondents to assist in preparing the list subjoined, the Committee of the Washington Academy of Sciences asked that the tests to be applied in selection of books should be as follows: "(1) The book must be *readable*; if the average visitor to the library takes the book home, it will interest him so much that he will read it through, and will come back to ask the librarian for another on the same subject. (2) It must be *accurate*; preferably written by one who knows his subject at first hand. Minor points are: (3) up-to-dateness; (4) small bulk; (5) attractive binding, type, and illustrations.

"The relative number of books in different branches of science is not fixed. For example, a good book in mathematics may be substituted for a poor book in anthropology, provided anthropology is not thereby left wholly unrepresented."

The Committee has performed a useful service in selecting one hundred books which it feels fairly sure are scientifically trustworthy, and believes to be readable. It is obvious that a list of this kind must be subject to revision, and indeed should be revised frequently to keep up with the progress of science and the publication of books better adapted to the purpose. The Committee adds: "In general, it need hardly be said that even a tried and tested list can never be completely satisfactory, for the simple reason that there is no such person as the 'average reader.' Every individual has his own foundation of natural capacity and education, and his own background of experience and interests. We therefore need one series of lists covering all types of capacity, another series differentiated according to kind and duration of education, another series distributed according to age and to variety of experience, and still another adapted to the varied types of man's interests. Provided with such a set of lists we could name twenty-five scientific books which would be almost certain to interest keenly any given individual. Lacking such provision, we can only hope, on behalf of the very general list herewith submitted, that every reader who can be induced to read anything at all serious will find on the list a few books which appeal to him strongly, and that none of the other books will give him the impression that science makes reading-matter which is difficult or forbidding."

General Science.

1. J. Arthur Thomson, Editor. The Outline of Science.
2. Thomas Henry Huxley. Selections from Huxley.

Man.

3. Edward L. Thorndike. The Human Nature Club.
4. William James. Psychology.
5. Robert S. Woodworth. Psychology; a Study of Mental Life.
6. Henry Fairfield Osborn. Men of the Old Stone Age; their Environment, Life, and Art.
7. O. T. Mason. The Origins of Invention.
8. O. T. Mason. Woman's Share in Primitive Culture.
9. Walter Hough. The Hopi Indians.
10. E. V. McCollum. The Newer Knowledge of Nutrition.
11. H. C. Sherman. Food Products.
12. Walter H. Eddy. The Vitamine Manual; a Presentation of Essential Data about the New Food Factors.
13. E. O. Jordan. Food Poisoning.
14. William Williams Keen. Medical Research and Human Welfare.
15. Ellsworth Huntington. Civilization and Climate.

Heredity.

16. Charles Darwin. The Origin of Species.
17. E. M. East and D. F. Jones. Inbreeding and Outbreeding.
18. W. D. Castle, J. M. Coulter, C. B. Davenport, E. M. East, and W. L. Tower. Heredity and Eugenics.
19. T. H. Morgan. A Critique of the Theory of Evolution.
20. E. G. Conklin. Heredity and Environment.
21. Francis Galton. Hereditary Genius.
22. Paul Popenoe and R. H. Johnson. Applied Eugenics.

Biology.

23. J. Arthur Thomson. The Wonder of Life.
24. J. Arthur Thomson. The Haunts of Life.
25. E. L. Bouvier. The Psychic Life of Insects.
26. Winterton C. Curtis. Science and Human Affairs.
27. William A. Locy. Biology and its Makers.

Zoology.

28. A. B. Buckley. The Winners in Life's Race.
29. E. W. Nelson. Wild Animals of North America.
30. Theodore Roosevelt. African Game Trails.
31. C. W. Beebe. Jungle Peace.
32. Witmer Stone and W. E. Cram. American Animals; a Popular Guide to the Mammals of North America north of Mexico.
33. Frank M. Chapman. Camps and Cruises of an Ornithologist.
34. J. H. Fabre. Social Life in the Insect World.
35. Maurice Maeterlinck. The Life of the Bee.
36. Oliver P. Jenkins. Interesting Neighbors.
37. W. S. Blatchley. Gleanings from Nature.
38. Alfred G. Mayer. Sea-shore Life.

Botany.

39. W. F. Ganong. The Living Plant; a Description and Interpretation of its Functions and Structure.
40. W. J. V. Osterhout. Experiments with Plants.
41. Paul Sorauer. A Popular Treatise on the Physiology of Plants for the use of Gardeners or for Students of Horticulture and Agriculture.

42. Marcel E. Hardy. The Geography of Plants.
43. Charles Darwin. Insectivorous Plants.
44. C. W. Townsend. Sand Dunes and Salt Marshes.

Microscopic Life.

45. René Valery-Radot. Louis Pasteur, his Life and Labours.

Paleontology.

46. F. A. Lucas. Animals of the Past.
47. H. N. Hutchinson. Extinct Monsters and Creatures of Other Days; a Popular Account of some of the Larger Forms of Ancient Animal Life.

Geology and Geography.

48. J. W. Gregory. Geology of To-day.
49. Hallam Hawkesworth. The Strange Adventures of a Pebble.
50. R. S. Lull and others. The Evolution of the Earth and its Inhabitants.
51. T. C. Chamberlin. Origin of the Earth.
52. George P. Merrill. The First One Hundred Years of American Geology.
53. Ellen Churchill Semple. Influences of Geographic Environment.
54. J. E. Spurr, Editor. Political and Commercial Geology and the World's Mineral Resources.
55. Albert P. Brigham. Geographic Influences in American History.

Geologic Agents.

56. John Tyndall. The Forms of Water in Clouds and Rivers, Ice and Glaciers.
57. T. G. Bonney. The Work of Rains and Rivers.
58. T. G. Bonney. Volcanoes, their Structure and Significance.
59. Israel C. Russell. Volcanoes of North America.
60. Charles Davison. The Origin of Earthquakes.

Meteorology.

61. R. G. K. Lempfert. Weather Science.
62. R. de C. Ward. Climate, considered especially in Relation to Man.

The Ocean.

63. John Murray. The Ocean.

Rocks and Minerals.

64. Grenville A. J. Cole. Rocks and their Origins.

Astronomy.

65. Robert S. Ball. The Story of the Heavens.
66. F. W. Dyson. Astronomy.
67. George E. Hale. The New Heavens.
68. Charles G. Abbot. The Sun.
69. Isabel M. Lewis. Splendors of the Sky.
70. Kelvin McKready. A Beginner's Star Book.
71. H. H. Turner. A Voyage through Space.
72. Arthur Berry. A Short History of Astronomy.

Chemistry.

73. E. E. Slosson. Creative Chemistry.
74. Ellwood Hendrick. Everyman's Chemistry.
75. Henry C. Fuller. The Story of Drugs.
76. Jean Henri Fabre. The Wonder Book of Chemistry.
77. Robert Kennedy Duncan. The Chemistry of Commerce.
78. Geoffrey Martin. Modern Chemistry and its Wonders.
79. Frederick Soddy. The Interpretation of Radium.
80. F. P. Venable. A Short History of Chemistry.
81. Edgar Fahs Smith. Chemistry in America.

Physics.

82. Frederick Soddy. Matter and Energy.
83. John Mills. Within the Atom.
84. Albert Einstein. Relativity.
85. J. A. Fleming. Waves and Ripples in Water, Air, and Aether.
86. Dayton C. Miller. The Science of Musical Sounds.
87. William Bragg. The World of Sound.
88. Marion Luckiesh. Color and its Applications.
89. C. V. Boys. Soap Bubbles: their Colours and the Forces which Mould them.
90. Ernst Mach. Popular Scientific Lectures.
91. Frederick Soddy. Science and Life.

Mathematics.

92. A. N. Whitehead. Introduction to Mathematics.
93. Levi Leonard Conant. The Number Concept, its Origin and Development.
94. John Wesley Young. Lectures on the Fundamental Concepts of Algebra and Geometry.
95. James Byrnie Shaw. Lectures on the Philosophy of Mathematics.
96. Augustus De Morgan. On the Study and Difficulties of Mathematics.
97. David Eugene Smith. Number Stories of Long Ago.

History of Science.

98. Walter Libby. An Introduction to the History of Science.
99. W. T. Sedgwick and H. W. Tyler. A Short History of Science.
100. Andrew D. White. A History of the Warfare of Science with Theology in Christendom.

The Zermatt Meeting of the Swiss Society of Natural Science.

The 104th meeting of the Helvetic Society of Natural Science was held at Zermatt on August 30–September 2. On the evening of the first day, after a business meeting in which Lucerne was chosen as the meeting-place for next year, the Society was welcomed by the local and cantonal authorities at a soirée given by the Science Society of the Rhone Valley, called the Murithienne. The next day, which was very wet, was devoted appropriately to business: general meeting with speeches in the morning; sectional meetings in the afternoon.

M. le Chanoine Besse, curé of Riddes, who had been chosen as annual president, took the opportunity of his opening address piously to recall the names and the lifework of some of the most prominent *savants* of the valley. A member himself of the Congregation of St. Bernard, he was able to point to the long tale of patient study pursued by successive members of the same body; in particular he sketched the life of Laurent-Joseph Murith, 1742–1816, geologist, conchologist, ornithologist, entomologist, as well as archæologist, who lived just long enough to be one of the first members of the infant Helvetic Society. Among the other men whose lives he told in impressively simple language I would only mention that of Walther Ritz, 1878–1909, the brilliant young

physicist, born at Sion, whose ideas not only made a great stir at the time, but have also proved a source of inspiration since.

In the various Sections a number of interesting communications were made. The Mathematical Section opened with a causerie of my own on the nuptial number of Plato. Prof. Speiser then explained a very pretty geometrical figure of rational points on the straight line and circles touching the latter in those points and touching one another, and Prof. Wavre, of Geneva, gave a short account of some work on a substitution in the realm of several complex variables. After the meeting I communicated by desire a new theorem of Prof. W. H. Young's in the theory of trigonometric series; he had promised to speak on this subject, but was prevented from attending the meeting. I pointed out how the theorem itself as well as the proof again illustrate the efficacy of the method of integration with respect to a function of bounded variation.

In the Physical Section the communications fell distinctly into two classes, pure and applied, the latter being in the majority. The former included an account of the separation of neighbouring radioactive substances as carried out in the Brussels laboratory of August Piccard, and another of experiments made in Prof. Perrier's laboratory at Lausanne by S. Gagnebin, on the thermic variation of the dielectric constants of quartz. These latter form part of a general scheme of research undertaken in the Lausanne laboratory on the dissymmetries of solid matter; they constitute, moreover, a fine example of the use of the triode lamp in the problem of measuring exceedingly feeble capacities with imperfect isolation. In applied physics we may in particular mention an account of the determinations of the variation of the first modulus of the elasticity of steel under changes of temperature, made in Prof. Jaquerod's new horological laboratory at Neuchâtel; it is expected that the result of the creation of this department will have a beneficial effect on the Swiss watchmaking industry. Almost all the remaining contributions consisted of technical improvements in telegraphy and wireless telephony, among which we note the realisation of very simple and strong, but small, apparatus, of national importance to Switzerland in so far as they are to be set up in the huts of the Alpine Club.

The Botanical Section was strongly represented. P. Konrad gave an account of his researches on certain fungi in the Jura; in particular he has found a new type of Hymenomycetes which enables him to settle certain systematic questions hitherto unsolved. Prof. Schinz, of Zürich, showed a collection made by one of his staff, Prof. A. Thelling, unfortunately himself absent, of the flowers of Zermatt, corroborating, among other things, the known fact that, in this region, plants are able to exist at a greater height than in other parts of Switzerland.

Dr. W. Vischer, of Bâle, spoke upon heredity in relation to the physiological properties of *Hevea Brasiliensis*, the chief rubber producing plant at the present time. Prof. E. Fischer, of Berne, gave two communications; the first on the work carried out under his direction by Dr. Baumgartner, who has been able to show that an interesting family of fungi, the Laboulbeniaces, hitherto supposed to be confined almost exclusively to North America, contains numerous representatives in Switzerland. The excessive minuteness of these organisms renders their recognition extraordinarily difficult. The second of Prof. Fischer's communications related to the infection of certain plants by rust-fungi (Uredineæ), which he had collected in the Rhone valley, and by means of which new light is thrown on the susceptibility of determinate races or groups of plants to infection by definite fungi. Prof. Jäggli gave great pleasure to his audience by his account in Italian of the mosses he has studied in the pass of Sasso Corbaro, near Bellinzona; he has found several hitherto unknown in the Tessin. The remarkable variety found in such a small area is doubtless due to the lie of the region in relation both to the Alps and the Mediterranean. Fernand Chodat, the son of Prof. Chodat, of Geneva, spoke upon the determination of the concentration of hydrogen ions in the soil and its influence on the vegetation. In places where the same group of plants occurs, the concentration is found to be remarkably constant in spite of external differences of the surroundings; hence it may be expected that this factor plays an important part in the distribution of plants. Prof. Schellenberg, of Zurich, spoke upon a subject closely connected with that of Prof. Fischer's second communication. The parasitic fungus which formed the subject of his investigations, Sclerotinia, attacks especially the quince tree, and others of the same family.

In the Section of Geophysics, Meteorology, and Astronomy, we may refer to an interesting communication by O. Lütschg, of Bern, giving exact details with respect to the advance of a certain glacier founded on archives of the year 1300; and in the Section of Anthropology and Ethnology, in addition to the account given by Prof. Pittard, of Geneva, on Palæolithic traces in Northern Africa, we must notice H. Junod's communication on totemism among the Tongas, Pédis, and Vendas. The curious customs which he had chronicled during his long residence in South Africa among these peoples seem to indicate that the totemism which exists, more particularly among the Pédis, may be a relic of the past, the real meaning of which has been lost and the practice become degenerate.

Among other communications of interest we note, in the Section of the History of Medicine and of Science, Dr. Morgenthaler's account of a hysterical case at the beginning of the sixteenth century. The account as written down by the doctors at the time is so exact that it is possible in the present day to diagnose the case precisely. In those days the patient was fortunate to escape being tried and burned for witchcraft. In the same Section, Prof. G. Senn examined carefully the pharmaceutical-botanical handbook of Theophrastus (chapters 8-20 of his "Historia plantarum"), and came to the conclusion that we have here a conglomerate of results from various sources, which were edited rather inefficiently at a later date by an unknown person. Nevertheless, the book has scientific value, and certainly contains parts due to Theophrastus.

In each of the Sections there was, besides the scientific communications read and discussed, a business meeting which, for the most part, presents no interest to a British public; we notice, however, with pleasure that Sir Clifford Allbutt was elected an honorary member of the Society, in recognition of his important contributions to the history of medicine. In the Physical Section, moreover, two matters of general interest came up: first, the question of the federation of the Swiss Physical Society with the International Union of Pure and Applied Physics, and secondly, the creation of a Swiss periodical for physicists. The Helvetic Society as a whole had already given in its adhesion to the International Research Council, and the question was put by the central president to the Physical Society, as a branch of the larger body. It was decided to answer in the affirmative. A Swiss Committee of Physics was there and then constituted, comprising

provisionally five Swiss members. This committee is to be considered as distinct from the committee of the Swiss Physical Society, which may contain non-Swiss members, and the possibility was left open of its being enlarged at a later date by the addition of electrical engineers, or representatives of other branches of applied physics. The committee will examine shortly the question of sending a delegation to the meeting which it is proposed to hold in December at Paris.

In discussing the second matter, it was pointed out that there does not exist at the moment any Swiss periodical devoted exclusively to physics, and in which memoirs in any one of the three national languages equally are accepted. The consequence is that much of the good work done in Swiss institutions is regarded outside Switzerland as belonging to the countries where the results are published. On the initiative of some of its members, the Society decided to consider at an early date the creation of a trilingual review, of the type of the *Helvetica Chimica Acta*, recently created for the purpose of publishing the work of Swiss chemists in Switzerland itself. The question is more difficult in the case of physics, since, unlike chemistry, it cannot count on the regular support of the industrial people. A committee *ad hoc* is to examine whether it will prove possible to transform and extend the *Archives des Sciences Physiques et Naturelles*, hitherto published at Geneva. This was the wish of Philippe Guye, and he had for years been working with this aim in view, when his untimely death deprived the world of science of one of its most valued leaders. It is to be hoped that the preparations which he had made will be found to render this transformation possible. The alternative would be to create a totally new review, the *Helvetica Physica Acta*.

GRACE CHISHOLM YOUNG.

University and Educational Intelligence.

BRISTOL.—Prof. J. W. McBain has received the degree of doctor of science from Brown University, Rhode Island, United States, where he is delivering a dedicatory address at the opening of the new chemical laboratories.

CAMBRIDGE.—Mr. H. Godwin, Clare College, has been appointed junior demonstrator in botany, and Mr. H. E. Green, Fitzwilliam Hall, re-appointed second assistant at the Observatory.

Dr. Mollison, Master of Clare College, has offered a gift of 500*l*. to found a prize to be called the "Mayhew Prize," to be awarded by the examiners in Part II. of the Mathematical Tripos to the candidate of the greatest merit, preferably in the subjects of applied mathematics.

LONDON.—Dr. A. Logan Turner will deliver the Semon lecture in the lecture hall of the Royal Society of Medicine, 1 Wimpole Street, W.1, on Thursday, November 1, at 5 o'clock, taking as his subject "The Advancement of Laryngology: a plea for adequate training and closer co-operative action." Admission will be free, without tickets.

A course of eight lectures on "Some Biochemical Aspects of Animal Development" is being delivered by Mr. H. G. Cannon in the Zoological Department of the Imperial College of Science and Technology on Mondays at 5.30, terminating on December 3.

SHEFFIELD.—The University Council has made the following appointments: Prof. F. C. Lea, to the chair of mechanical engineering, in succession to emeritus Prof. Ripper; Mr. R. R. S. Cox, to be assistant lecturer and tutor in mathematics; and Mr. M. H. Evans, to be an assistant lecturer in physics.

ACCORDING to the *Chemiker Zeitung*, Dr. James Franck has been appointed to the chair of physics in the University of Berlin, vacant by the death of Dr. Heinrich Rubens.

THREE residential scholarships for British women graduates, tenable at the American University Women's Club in Paris, have been awarded by the British Federation of University Women to the following candidates: Miss Olive Farmer (London and Cambridge)—Mary Ewart Travelling Scholar, 1923–24; Miss Benedicta J. H. Rowe (Oxford); and Miss Helen Waddell (Belfast)—Susette Taylor Fellow, 1923–24.

THE Department of Leather Industries of the University of Leeds has issued a report on the sessions 1921–23, in which it is noted that the Ph.D. degree of the university was conferred on completion of two years' research work in the department on Mr. E. C. Porter for a thesis on "The Alkaline Swelling of Hide Powder," while another former student of the department, Mr. F. L. Seymour-Jones, has been awarded a Ph.D. degree by Columbia University for a thesis on "The Hydrolysis of Collagen by Trypsin."

THE University of Leeds entertained on September 13 a party of members of the Institute of Journalists. In connexion with this visit a convenient summary of the history and activities of the University was printed, special prominence being given to the departments of Leather Industries, Colour Chemistry, and Textile Industries, all of which were inspected by the visitors. It is noted that to provide university instruction costs on an average 83*l*. a year for each full-time student, while the average fee paid by such students is 40*l*.

AN article on "The Civic University and the State" in the *Fortnightly Review* for October contains a timely plea for the recognition of the importance from an Imperial point of view of adequate provision in the English provincial universities for economic and industrial research and advanced studies in civics. Mr. MacInnes, the writer of the article, points out that were full advantage taken of the unique opportunities in the universities of Birmingham, Bristol, Leeds, Liverpool, Manchester, and Sheffield, for work in these fields they would attract from the Dominions many research students who would otherwise drift to foreign countries. Hitherto these universities have attracted very few of such students, owing partly to failure to make their resources sufficiently well known and to devise convenient procedures for students from abroad. Nor is this surprising. The university staffs are hard put to it to meet the requirements of English students, and in the absence of any special inducement to cater for the needs of students from abroad, it is not to be expected that they should go out of their way to do so. Something has been done by the Universities Bureau to disseminate in every part of the Empire a knowledge of the resources of the universities in other parts, but that is not enough by itself to stimulate intra-Imperial migration of students. Discussing the perils to which universities are exposed by reason of dependence on State subsidies, the article points out that a democratic community naturally inclines to the view that, since the people pay for their maintenance, as many persons as possible should enjoy their benefits, and as a large majority fail to appreciate the benefit of having in their midst a university pursuing, however efficiently, its traditional aims, they are inclined to look for benefits more direct and easily recognisable.

Societies and Academies.

MANCHESTER.

Literary and Philosophical Society, October 9.—H. B. **Dixon**: On coal-dust explosions at the Mines Department Experimental Station at Eskmeals. The coal-dust theory of explosions in mines, started fifty years ago, led to many small-scale experiments, both in England and abroad, which did not definitely solve the problem. The large-scale experiments instituted by the Mining Association in 1908 first showed the violence of pure coal-dust explosions and indicated methods to study and counteract them. In the model mine at Eskmeals, Cumberland, it has been possible to give complete demonstrations of the violent character of pure coal-dust explosions, and to obtain records of the speed and pressure of the flame. It has also made possible many experiments on the effect of damping the dust and of diluting it with inert shale or other incombustible powders. The Eskmeals Committee in 1914 advised a 1 : 1 mixture of coal and inert dust throughout the roadways of "dry and dusty" mines—as a minimum amount of inert dust. The experiments made this year with the finely ground dust from various coal seams in England and Scotland—especially that with the Arley Main dust—have shown that it is possible to explode a 1 : 1 mixture. But the precautions taken to meet the coal-dust danger have resulted in a great saving of human life. The yearly fatal accidents from explosions in mines during the decade 1873–1882 reached 661 per million workers, in the decade 1911–1920 the yearly average fell to 111; for the last three years the average has been still lower.

MELBOURNE.

Royal Society of Victoria, August 2.—Mr. Wisewould, president, in the chair.—C. **MacKenzie** and W. J. **Owen**: Studies on the comparative anatomy of the alimentary canal of Australian reptiles. The alimentary canals of lizards, skinks, monitors, and of poisonous and non-poisonous snakes, were described. Without a knowledge of the reptilian gastro-intestine there could not be a correct understanding of the apparent complex human intestinal arrangement and its method of fixation adapted to the erect posture. In the bearded and the frilled lizards, a well-defined cæcum appears together with development of mesenteric colon (human ascending colon). Associated with this is the presence of the mesial fold approximating the colon to the pyloric region, which is best demonstrated in Koala. Thus in these lizards is found early evidences of the method of accommodation of the large intestine to the erect posture.—G. G. **Heslop**: Further studies in contagious bovine pleuropneumonia.—E. W. **Skeats**: The evidence of Post-Lower Carboniferous plutonic and hypabyssal intrusions into the Grampian Sandstones of Western Victoria.—A. Jefferis **Turner**: New Australian Micro-Lepidoptera.—F. **Chapman** and C. J. **Gabriel**: A revision of the Australian Tertiary Patellidæ, Patelloidiidæ, Cocuclinidæ, and Fissurellidæ. The fissure, keyhole, and common limpets are discussed. Of the 23 species described, 14 are new. Three of the fossil species are still found living, and have an ancestry dating back three million years, the fossils being indistinguishable from those dredged up in Western Port Bay. The persistence of these species supports the idea of the general stability of the Australian continent since ancient geological time, so far as the absence of sudden changes of coast-line is concerned.

Diary of Societies.

MONDAY, OCTOBER 22.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Arteries.

INSTITUTE OF PHYSICS (at Institution of Electrical Engineers), at 5.30.—Dr. A. E. Oxley: The Physicist in the Textile Industries.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—J. Harrison: Four-wheeled Brakes for British Light Cars.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—D. Caush: Presidential Address.

TUESDAY, OCTOBER 23.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions made to the Society's Menagerie during the months of June, July, August, and September 1923.—E. A. Spaul: Acceleration of Metamorphoses of Frog-Tadpoles by Injection of Anterior-lobe Pituitary gland Extract and Iodine.—H. C. Abraham: A New Spider of the Genus Liphistius from the Malay Peninsula, and some Observations on its Habits.—A. Subba Rau and P. H. Johnson: Observations on the Development of the Sympathetic Nervous System and Suprarenal Bodies in the Sparrow.—M. A. Smith: A Review of the Lizards of the Genus Tropidophorus on the Asiatic Mainland.—J. G. H Frew: The Larval Anatomy of the Gout-fly (*Chlorops taeniopus* Meig) and two Related Acalyptrate Muscids with Notes on their Winter Host-plants.—A. Loveridge: (1) Notes on Mammals collected in Tanganyika Territory, 1920–1923. (2) A List of the Lizards of British East Africa (Uganda, Kenya Colony, Tanganyika Territory, and Zanzibar), with Keys for the Diagnosis of the Species.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—W. S. Patterson: Boiler Corrosion.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. G. H Rodman: A Talk about the Housefly and how it endangers the Health of Man.

ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society), at 8.15—F. A. Mitchell-Hedges: The Discovery of an Unknown Race: The Culture of the Calchaqui of Central America.

WEDNESDAY, OCTOBER 24.

FEDERATION OF MEDICAL AND ALLIED SERVICES (at 12 Stratford Place), at 4.—Conference to consider what practical means, if any, are possible to extend the system of providing for the periodical medical examination of the Larger Assurance Policy Holders.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.—J. E. Barnard: Lecture Demonstration dealing with the Efficient Use and Manipulation of the Microscope.—Dr. Marie C. Stopes: The Microscopy of Recent Coal Research.

THURSDAY, OCTOBER 25.

ROYAL SOCIETY OF MEDICINE, at 5.—Sir E. Sharpey Schafer: The Relations between Surgery and Physiology (Victor Horsley Memorial Lecture).

SOCIETY OF DYERS AND COLOURISTS (London Section) (at Dyers' Hall, Dowgate Hill), at 7.—I. E. Weber: Hydrogen Peroxide Bleaching.

FRIDAY, OCTOBER 26.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—S. H. Piper and E. N. Grindley: The Fine Structure of some Sodium Salts of the Fatty Acids in Soap Curds.—Dr. E. A. Owen and G. D. Preston: X-ray Analysis of Solid Solutions.—Dr. H. Chatley: Cohesion.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Distinction between Congenital and Acquired Forms of True Hernia.

NEWCOMEN SOCIETY (in Prince Henry's Room, 17 Fleet Street), at 5.30.—L. St. L. Pendred: The Value of the History of Technology (Presidential Address).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. E. Saunders: Adventures with a Camera at the Zoo.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. V. Ballhatchet: Crystals for Wireless Reception.

PUBLIC LECTURES.

SATURDAY, OCTOBER 20.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Tutankhamen and his Times.

MONDAY, OCTOBER 22.

UNIVERSITY COLLEGE, at 5.—Miss H. M. Holdsworth: The Problem of teaching Spoken English to Foreigners.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—H. G. Cannon: Some Biochemical Aspects of Animal Development. (Succeeding Lectures on October 29, November 5, 12, 19, 26, and December 3.)

TUESDAY, OCTOBER 23.

UNIVERSITY COLLEGE, at 5.30.—P. Fleming: The Care of School Children's Eyesight.

GRESHAM COLLEGE, BASINGHALL STREET, at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on October 24, 25, and 26.)

WEDNESDAY, OCTOBER 24.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. J. C. Drummond: Vitamins in relation to Public Health.

UNIVERSITY COLLEGE, at 5.30.—T. G. Hill: Illustration of Books.

THURSDAY, OCTOBER 25.

FINSBURY TECHNICAL COLLEGE (Leonard Street), at 4.—E. M. Hawkins: Analytical Chemistry (Streatfeild Memorial Lecture).

FRIDAY, OCTOBER 26.

UNIVERSITY COLLEGE, at 5.15.—B. Seebohm Rowntree: Factory Life as it is and as it might be.

SATURDAY, OCTOBER 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30—E. Lovett: The Legendary Folklore of the Sea.

NATURE

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Science and the State.

AT the session of the Imperial Economic Conference on October 16, Lord Salisbury, Lord President of the Council, made a statement with regard to the Department of Scientific and Industrial Research. In the course of his remarks he said that it has become more and more accepted that the business of research is really an essential element in the industrial progress of the country. Notwithstanding that we all believe in private enterprise, a measure of Government intervention and research is requisite in this, as in many other things.

There are several phases of research which the Research Department has under its purview; for example, maintenance of industrial and commercial standards, work for Government services, and research for industrial purposes. As regards industrial research, while it is likely that the work of private enterprise will be more efficient than that of a Government department, on the other hand the Government possesses certain advantages. For example, the State can afford to finance researches which may prove to be so protracted as to be beyond the scope of private enterprise. Again, the Government has at its command an immense mass of accumulated knowledge. Thirdly, and this point of Lord Salisbury's is one which calls for comment, there is a large number of scientific men who are willing to work for the Government at far less than would be the remuneration of their great talents, and are willing through the Government to place their knowledge at the service of the community. If Lord Salisbury implies by this that the Government is willing and ready to trade upon the patriotism of a research worker, or upon his desire for the security of tenure which is so vital if he is to do good work, then it is truly a deplorable statement. Too often is it assumed that scientific men should be expected to work for the Government at less than would be the just remuneration of their services, though rarely are the mercenary advantages of the one-sided arrangement so baldly claimed by a responsible Minister.

Lord Salisbury went on to refer to the National Physical Laboratory as the outstanding illustration of the success of what in the long run is probably the biggest element of progress in industry, and that is research by the Government itself for industrial purposes. He stressed also as of Imperial importance the work of the Forest Products Board in connexion with timber, and of the Food Investigation Board on the transport of fruit overseas. Lord Salisbury concluded by paying a tribute to the business-like and economical administration of the Research Department.

Officialism in Education.[1]

The British Science Guild has issued a Memorandum on the subject of bureaucratic intervention in education, which, it states, has reached an acute stage and "has become detrimental to educational development and efficiency." The main charge made by the Guild is that official intervention in educational administration, as distinguished from efficient educational control, is now so excessive—both on the part of the Board of Education and Local Education Authorities—that governing bodies of Technical Institutions and Secondary Schools are becoming mere advisory bodies, without any freedom of action which would allow them to develop the individuality of their institution and take a lively and responsible interest in their progress. It is also pointed out that heads, appointed for their educational powers, are crippled by officialism, both as regards initiative and freedom to experiment on one hand, and on the other by the large demands for clerical work in the nature of "returns," which unduly curtails the time which they can devote to their proper work as educationists.

There have been similar protests from other sources. Local Education Authorities have themselves protested against the apparent endeavours of the Board of Education to assume greater control of matters which should be left to local discretion and to local knowledge. Here we find the British Science Guild accusing Local Education Authorities of acting similarly towards governing bodies of educational institutions. We have also heard of heads who have made similar protests against their governing bodies. We do not suggest that the protests are unwarranted. On the contrary, we think that there is much official intervention that is not only unnecessary and expensive, but is also detrimental to educational development.

We have an example in the working of the new scheme of national certificates in chemistry and in mechanical and electrical engineering, referred to in an article in Nature of July 14, p. 45. Apparently the scheme is designed to secure all the advantages of internal examinations and of reasonable freedom in the arrangement of the courses of work to meet local conditions and needs, coupled with just enough central control and assessment to secure the attainment of some uniform *standard* of work on which a national certificate can be issued, bearing the endorsement of the Board of Education and of the appropriate institution of chemists or engineers. The scheme is excellent, but we have reason to fear that before courses of study are recognised they are so modified—"mutilated" was one word which we heard—by the Board that they all bear a close resemblance to one another. If such be the fact, it is certainly an example of hampering local discretion and tending too much towards that machine-like uniformity beloved by bureaucrats, whose tendency is to worship at the shrine of organisation and to ignore the essential needs of educational progress.

We are not blind to the need of some measure of central control and to some sound and efficient organisation, but any attempt to standardise education, whether in school, technical institution, or university, is just as certain to put an end to progress as is the standardisation of any machine—like a motor-car, for example—bound to prevent any development or improvement in that particular machine. If the increased bureaucratic intervention which is complained of is tending to do this thing, then it must be resisted strenuously.

[1] Memorandum on the Increase of Bureaucratic Intervention in Education. (British Science Guild.)

The Lister Ward of Glasgow Royal Infirmary.

The managers of the Royal Infirmary, Glasgow, recently decided that, for various reasons, the celebrated Lister Ward of the Infirmary should be destroyed. It is not surprising to know that this decision has elicited many strong protests, and that an appeal has been made for the preservation of what is a unique relic in the history of medical science.

The ward in question was Ward 24 of the "New Surgical House," and was Lister's male ward from 1861 to 1869. It was the scene of his first attempts to apply the results of his studies on the healing of wounds to combating the septic disease which was rampant. By their success it became the birthplace of modern surgery. In 1912, when the reconstruction of the Royal Infirmary had advanced so far that the ward was no longer used, it was decided to pull down the block in which it is situated. Then a movement arose for its preservation as a memorial of Lister, and the managers of the Infirmary decided to keep it.

This decision the managers later rescinded, and the ward has really escaped destruction through force of circumstances. It was arranged as a museum, with relics and portraits of Lister and hospital furniture of the period, for the occasion of the visit of H.M. King George on July 7, 1914, and a few weeks later it was occupied by wounded soldiers from France. Now it is in use as cloak-room and reading-room for the women medical students. The relics, etc., are stored in the Pathological Institute, and it is hoped to use them in furnishing the ward, so as to illustrate some of the conditions under which Lister worked in it—a task of no great difficulty.

The sentimental value of the place is felt by those who teach in the Royal Infirmary and by their students and by visitors from abroad. No one questions the value of Burns's cottage at Ayr; yet apparently the

majority of the managers of the Royal Infirmary regard Lister's ward only as an obstruction.

Recently a pamphlet has been published by Mr. James A. Morris (Glasgow: MacLehose, Jackson and Co.), who, besides telling the story of the ward, shows that if the proposals of the Lister Memorial Committee were carried out, there would be practically no obstruction left. Actually, it is not the whole block which it is desired to preserve, but only the one ward itself, with three little rooms, which are an integral part of it and the basement below. Providentially, it would seem, this one of Lister's wards was on the ground floor. An appeal is being made to the managers of the Infirmary in the hope that a definite and strong expression, not only by members of the medical profession, but also by all those who cultivate science, as to the "historical and spiritual values of this famous landmark in the history of surgery," will convince them that the destruction of the ward would be regarded as a breach of trust, and its preservation as a simple act of respect for a memorial of achievements by which all civilised peoples have benefited.

The New Anthropology.

Tutankhamen and the Discovery of his Tomb by the late Earl of Carnarvon and Mr. Howard Carter. By Prof. G. Elliot Smith. Pp. 133. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1923.) 4*s.* 6*d.* net.

LAST year's discovery of a rich and varied collection of funerary equipment and other objects of Egyptian art of the time of Tutankhamen must inevitably reanimate the already vigorous discussion of cultural origins and the meaning of cultural symbols and uses. The prediction of the late Dr. W. H. R. Rivers in 1911 that the theories then advanced by Prof. Elliot Smith would be bitterly opposed by ethnologists of the older school has been abundantly fulfilled. Those theories attributed the creation of civilisation as we know it the world over to Egyptian initiative, and since their author has now himself entered upon the discussion of the recent discoveries in Egypt, the occasion is afforded for presenting a review of at least the chief lines of the argument developed with ever-increasing weight of detail during the past decade. For most of them reference need be made only to this admirable little volume written particularly to interpret the essential features in Egyptian custom and belief which found expression in Tutankhamen's time.

First, then, concerning Egyptian funerary ritual and its origins in the life of the early Egyptian community, the achievement of the new anthropology is twofold: with true imaginative power it has penetrated the veil of mystery and unintelligibility, which is the obscuring work of later ages, to the naïve realism of the early Egyptian mind, and, allowing the proved facts of early life in the Nile basin then to speak for themselves, it has provided us with a complete and consistent account of the rise and spread of our culture. Civilisation, for the new school, began when the early Egyptians invented the art of irrigation to extend artificially the area of cultivation of barley. The irrigation-engineer of early Egypt was the first man to organise the labour of his fellows. He conferred the benefits of security and prosperity upon the community and upon every individual member of it. He personified every subsequent idea of kingship. The life of the community flowed from him in a sense as real and actual as that in which the Nile was subject to his control. To identify him with these subtle forces was less an act of metaphysical ingenuity than one of unsophisticated realism. He became the incarnation of the life-giving powers which he bestowed upon his people. He became a god, assimilating to himself attributes of the shadowy Great Mother, and was apotheosised after death as Osiris. Eventually his powers were extended and transferred to his successor, Horus, himself credited with the immortalisation of the dead king. The whole of the elaborate equipment of Tutankhamen's tomb is inspired by this same motive: identification with Osiris and participation in his immortality and deification.

Funerary couches such as the three discovered last year, one representing a cow, the second a lion, and the third a hippopotamus, have been known previously from fragments and are among the most familiar objects represented in wall-paintings and upon papyri. In themselves they shed a flood of light upon the essential *naïveté* of the Egyptian mind at work upon the elaboration of our human beliefs; but also they focus attention upon an important chain of evidences concerning the migration of culture. The cow in Egyptian belief was not only the giver of milk, maintaining life in childhood and adult age, a foster-mother; she was also, even sixty centuries ago, the Divine Cow, identified with the actual mother of mankind, the Great Mother, Hathor, who was at one and the same time a cowrie, a grain of barley (both symbols of life-giving), a cow, and the moon. If the great giver of life and immortality were both a cow and the moon, she was then the appropriate vehicle to transport the earthly king heavenwards. The representation of this occurrence is a commonplace of Egyptian painting, and realism could scarcely be carried further than rhe representation in some cases of the very stars upon the belly of the animal. The lion-headed couch of the tomb is inspired by a like motive. The lion was Horus, the

son of Osiris, as well as the Divine Cow the function of which was to perform those ceremonies which would ensure the continued existence of the father. The hippopotamus, a symbol of the divine midwife, brought about the rebirth of the king whereby he became a god. Immortality was the sole distinctive possession of a god in early times.

The use of such vehicles for human transportation to the celestial regions is widespread and is everywhere determinative of deity. The whole conception is so peculiar and so much a part of a particular community experience that it is incredible that two peoples independently should have adopted its remarkable symbolism. Yet it is found to have spread throughout western Asia and the parts of Europe that came under the influence of Greek civilisation; India and eastern Asia; Indonesia and Central America. The general adoption of such a convention affords a striking illustration of the diffusion of culture, and since its origin in Egyptian beliefs is demonstrated, its presence in Syria and Mesopotamia, in Asia Minor and Syria and Greece, in India and eastern Asia, in Central America and Peru, is but a measure of the world's cultural debt to Egypt herself. In India the convention exercised an exceptional fascination over the minds of its ancient inhabitants, who, from about three or four centuries B.C. onwards, were accustomed to represent the vehicles of the gods in many different guises. Of these, one of the most interesting was the *makara*, the composite monster regarded as a crocodile but originally nothing more than the capricorn of the zodiac—the Babylonian combination of antelope and fish. In India, too, a great variety of the heads of other animals were substituted from time to time for the antelope's, notably the elephant's.[1] These evidences are but amplifications, on the cultural side, of the formidable array of facts, somatological and cultural, elicited earlier. Craniological evidence from Polynesia, the Malay Archipelago, the Asiatic littoral, and the Pacific coast of Central and South America accords perfectly with the facts concerning the geographical distribution of the practice and technique of mummification, of megalithic monuments, and of ancient mines. Mr. W. J. Perry[2] has not only related these two last-mentioned cultural records, but has also explained the motives which impelled small bands of civilised people to wander and to settle.

The statement has been made, and repeated as recently as the present year by prominent archæologists well acquainted with the facts, that the Egyptians were not a sea-going people; whereas we know from their literature that they did engage in maritime enterprise, and it is perfectly well established that they invented shipbuilding and were the builders of the first sea-going ships. It is equally definitely established that every other people in the history of the world who engaged in maritime traffic adopted the Egyptian conventions of both shipbuilding and seamanship. It is unreasonable to pretend that the transportation of the elements of early civilisation from Egypt to Syria and Crete and East Africa and Babylonia was not effected by the Egyptians themselves. In each of those places Egyptian colonists exploited natural products and planted the germs of Egyptian civilisation, which in the course of its development acquired certain local peculiarities. But from Crete and Syria and Babylonia secondary diffusions took place in most cases, no doubt without direct Egyptian participation. The recognition of cultural elements of Egyptian inspiration in India by no means involves the claim that either a single Egyptian or a single Egyptian word ever reached that country. The first is necessitated by the facts: the second is an unessential possibility. A Babylonian *element* colours the southern Indian culture; an Indian *element* that of Burma, Siam, and Cambodia. Behind all is the Egyptian origin and inspiration.

Most of the misunderstanding concerning the new theories has been due to a failure to understand the nature of such secondary diffusion. It cannot be made too clear that no claim has been advanced on behalf of direct transmission across great distances. The journeys may have been small, and few individuals may have achieved them, but the culture they bore with them was virile, and if degraded by change of hands, by time, and by racial and environmental as well as by merely geographical remoteness, it has not been degraded beyond recognition.

[1] Important evidence provided by the elephant-head in demonstrating the reality of the diffusion of culture so far as Scotland in the west and America in the east is set forth in correspondence in NATURE of Nov. 25, 1915, p. 340; Dec. 16, p. 425; Jan. 27, 1916, p. 592; Feb. 24, p. 703.

[2] "The Children of the Sun," 1923, etc.

Glass-making in England.

Glass-making in England. By Harry J. Powell. Pp. x+183. (Cambridge: At the University Press, 1923.) 25*s*. net.

ANY one who takes the trouble to look through a catalogue of works in English dealing with the subject of glass will be struck with its poverty. For the most part, books on glass have been written by collectors and admirers of glass for other collectors and admirers, or by antiquarians and artists interested in stained glass. The number of books written by those intimately connected with the manufacture of glass, however, has been remarkably few. Since 1849, when Apsley Pellatt wrote his "Curiosities of Glass Making," giving an account of the processes of making all kinds

of glassware, the number of books of any note, written by persons having intimate acquaintance with the industry, can be counted on the fingers of one hand. Thus, W. Gillinder's unpretentious but, in its day, useful little book appeared in 1854; in 1883, H. J. Powell, to whom we owe the volume under review, was the chief author of a book on the "Principles of Glass-making"; while, since 1900, two other books have appeared giving some account of the manufacture of glass. It is doubtful if any other important industry has so poor a technical literature.

Now, for the first time, if we except A. Hartshorne's work on "Old English Glasses," published in 1897, we have a general history of glass-making in England, one, indeed, written by a manufacturer of specially rich experience and knowledge of the handicraft. It is a matter of great regret that he did not live to see the actual publication of the book.

The book gives, in the space of fifteen chapters, a general survey of glass-making in England. It carries us back to the Roman occupation, discusses such remains of this period as have been discovered, as also of the glasses of Anglo-Saxon date, but without arriving at any definite conclusion on the existence of a native industry before the thirteenth century.

It was in 1226 that we first meet with the definite and undeniable existence of the industry in Great Britain, at Chiddingfold in Surrey. The south-eastern counties of England, Surrey and Sussex in particular, appear to have been favourite spots for the native glass-makers during the thirteenth, fourteenth, fifteenth, and sixteenth centuries, largely on account of the presence of much beechwood, which was the favourite fuel of the glass-maker. The native productions during these centuries do not appear to have reached a very high level, and it needed the impetus of foreign workmen from the middle of the sixteenth century onwards to raise the art of glass-making in Great Britain, some of these workmen coming from Venice and others from Lorraine by way of the Low Countries. The moving spirits, however, who assisted most effectively in the English developments were most of them Englishmen, of whom Sir Robert Mansell in the first half of the seventeenth century was the most persistent of the pioneers in the industry, being responsible for the development of glass-making at Newcastle and mainly instrumental in introducing coal instead of wood as the fuel in glass furnaces.

One of the achievements of this period, namely, the first part of the seventeenth century, was the production of lead crystal glass, which constituted a contribution of fundamental importance to the industry and was destined, in virtue of its capacity to bear cutting and decorating, to supplant the famous Bohemian glass for ornamental purposes. By the middle of the eighteenth century the English crystal glass was already beating the Bohemian glass as that previously had beaten the Venetian.

Of considerable interest is chap. iv., on English drinking glasses, since it presents the view of a glass manufacturer and opposes various theories of glass collectors. Mr. Powell held the view, with which the reviewer heartily concurs, that connoisseurs have often attempted too much in endeavouring to assign dates and periods to articles of glassware on the basis of variety of form, of decoration, and of tint. Artistic development and skill varied so considerably from factory to factory that it was quite possible for different forms, both simple and highly developed, to be produced at contemporary factories; whilst it is a comparatively simple matter to reproduce tints in glass. Some factories, indeed, have made a study of the reproduction of antique glasses, and the author himself was responsible for some fine reproductions of Venetian glass.

Chap. xiv. is of special interest from the point of view of the scientific development of glass. It contains notes of the author's own experience as a glass manufacturer between the years 1875 and 1915, and the experiments recorded prove that there was at least one works in Great Britain which did not depend on rule-of-thumb methods. A study of the records of the provincial glass-houses (chap. vii.) shows that enterprise was by no means lacking, even during Government control (see chap. xii., the Excise Period), when it was a matter of surprise that men could still be found to carry on glass manufacture under the conditions prescribed by law, which insisted that notice in writing must be sent to the Excise Officer before any of the important operations of glass-making could be carried out.

Not unnaturally, the main portion of the book is concerned with glass-making as an art. As a handicraft the author's view was that glass-making was doomed. He states so quite definitely in the preface; and, whether his view be correct or not, it was the chief factor at any rate which induced him to write this account. The disappearance of glass-making as a handicraft and the introduction of the machine, however, did not necessarily mean to him the final loss of the artistic in glass. He says: "If mechanically produced tableware is inartistic and ugly the fault lies with the designer. . . . Designs, whether for hand-made or mechanically produced tableware must be evolved from an intimate acquaintance with the nature of molten glass and the technique of manufacture rather than from the superior inner consciousness of the art school."

Several of the chapters of the book were written as lectures or as journal articles, and in some ways the book is therefore disjointed, whilst some of the chapter

headings do not convey the correct idea of the contents. Thus, one chapter (chap. x.) is devoted to the records of the famous Whitefriars factory, but its chief title is "Flint Glass." The chapter on "Old London Glass-houses" (chap. vi.) and that on "Provincial Glass-houses" (chap. vii.) both contain much detailed information, including such references as occur to the investigations of Faraday, Harcourt, and of Stokes on optical glass, and, indeed, to the whole subject of optical glass—except the brief reference later on to War developments.

One would like to have seen included some account of trade union influence in the nineteenth century, and something more about the condition of the industry in the last fifty years than the statement that it was in "a parlous state," while the concluding chapter (chap. xv.) on "Glass-making during the War" is somewhat sketchy. It may be admitted that the War developments gave a suggestion of what the future might be, and perhaps it was best that the detail should be left for the younger generation of men to fill in.

There is no existing book to which the one under review can be rightly compared. It stands as a definite and valuable contribution to our knowledge of the history of glass-making in Great Britain. The book is well got up and illustrated, containing one hundred and six illustrations, mostly photographic reproductions. W. E. S. TURNER.

Fungi and their Spores.

Researches on Fungi. By Prof. A. H. Reginald Buller. Vol. 2: Further Investigations upon the Production and Liberation of Spores in Hymenomycetes. Pp. xii+492. (London: Longmans, Green and Co., 1922.) 25*s*. net.

PROF. BULLER'S original volume, entitled "Researches on Fungi," was published in 1909, and with its distinctive point of view and original observations attracted considerable attention among botanists. The author, in the preface to the present volume, states that it is to be considered as volume 2 of the original work, and that volumes 3 and 4 are in an active state of preparation. Such industry is itself remarkable, but such productivity in book publication is even more so at the present time, and is explained by the generous help towards publication provided by the Canadian National Council for Scientific and Industrial Research. The Birmingham Natural History and Philosophical Society has made a grant towards the cost of reproduction of the illustrations in the present volume, which include many beautiful photographs as well as a number of the author's original and extremely helpful diagrams.

The volume divides sharply into two sections. The first eight chapters are very diverse in character. They exhibit the author again as a born naturalist, making full use of the resources of a modern laboratory to extend the range of his interesting field observations. But it must be confessed that a certain diffuseness and prolixity make these early chapters difficult reading. Some of the material has been published before in the Transactions of the British Mycological Society, notably the chapters on slugs and squirrels as mycophagists, and all this early section might gain by condensation.

Chapters ix-xiii are very different in character. They include a most interesting attempt to interpret the organisation and development of the hymenium of the Agaricineae. In 1911 the author commenced this investigation upon the common mushroom, *Psalliota campestris*. Experience proved this plant an unsuitable starting-point, but realising the significance of the mottled appearance of the gills of Panaeolus, Prof. Buller worked out the progressive development of successive series of basidia and spores, in different phases in contiguous irregular areas on the mottled gill, and thus was successful in presenting a most complete analysis of the hymenial organisation. *Stropharia semi-globata* was similarly and most completely worked out, and incidentally might prove a better class object for the elementary student than the common mushroom, which only yielded up the secrets of its organisation when Prof. Buller returned to the attack armed with experience gained upon these other types. In this and the succeeding volumes the author promises an analysis of the two main types of hymenial organisation, that of Panaeolus and of Coprinus, and of the various sub-types he has distinguished.

This work must form the basis of laboratory study and teaching on the Agaric hymenium for many years to come. Interpretation throughout the work is entirely teleological, and while this permits a biological significance to be attached to many of the facts presented in so interesting a fashion with almost suspicious facility, it leaves the way open for a later reinterpretation of fungus organisation based upon a fuller knowledge of the complex machinery of heredity and growth and its relation to environment.

Geodesy and Geodynamics.

Naturwissenschaftliche Monographien und Lehrbücher. Vierter Band: *Einführung in die Geophysik*. Von Prof. Dr. A. Prey, Prof. Dr. C. Mainka, und Prof. Dr. E. Tams. Pp. viii+340. (Berlin: Julius Springer, 1922.) 12*s*. 6*d*.

THE title of the work under notice is a little misleading, and might better have been "An Introduction to Geodesy and Geodynamics," considering

that it contains no reference to such important branches of geophysics as terrestrial magnetism, earth currents, auroræ, and atmospheric electricity, not to say meteorology. Within its chosen limits, however, it affords a welcome summary of a considerable body of knowledge concerning the earth, which has not hitherto been accessible in anything like so concise and handy a form.

The work is divided into three parts, by different authors, but is as unitary a treatise as can be expected in the case of a wide field of rather loosely-connected studies such as geophysics. The first part occupies more than half the volume, and is distinguished from the two later parts by its largely mathematical character; it deals with the figure of the earth, the theory of tides and seiches, and the density and rigidity of the earth. The determination of the geoid by triangulation is first briefly explained, including an account of the essential features of the instruments used and the methods of reduction. The application of gravity measurements to the same problem is then dealt with; a short summary of potential-theory is followed by a description of the instruments and methods used in gravity-determinations, both absolute and relative; Clairaut's theorem connecting the ellipticity of the earth with the ratio of gravity at pole and equator and of gravity with centrifugal force at the equator is proved and discussed in connexion with observations for the north and south hemispheres separately. There is a brief chapter on measurement of heights above sea-level, by levelling, trigonometrical surveying, and barometric observations, followed by a longer but condensed summary of the changes of level of the sea itself; the tide-producing potential of the moon is developed, following Darwin in the main (not even a bare reference is made to the important work by Proudman and Doodson in this field), and the equilibrium theory, Laplace's dynamical theory, and Airy's canal theory of tides are summarised. Tidal currents and seiches are also touched on: the important influence of barometric pressure scarcely receives sufficient mention. The first part of the book ends with a long and interesting section on the constitution, mean density, and internal pressure of the earth; the basis and conclusions of the theory of isostasy are explained, and the various lines of evidence bearing on the rigidity of the earth are well summarised.

The second part of the book relates to seismology, and rapidly reviews the instruments used, the records obtained, and the conclusions thence derived as to the path and speed of the longitudinal and transverse waves, and the bearing of this evidence on the theory of the constitution of the earth.

The third section will probably be the most interesting to the majority of readers of the book, because it deals in a non-mathematical, discursive way with the borderland region between geodesy and geophysics. There the causes which have led to the present surface features of the earth are discussed. Without accepting Wegener's theory of continental displacements, the author adopts the broad principle that large lateral displacements of continental blocks must be taken into account in geology, though discounting the very uncertain astronomical evidence thus far adduced in favour of measurable rates of variation of relative longitude. Considerable space is also devoted to the causes of vulcanism and of earthquakes.

Our Bookshelf.

Civil Engineering Geology. By Cyril S. Fox. Pp. xvi + 144. (London: Crosby Lockwood and Son, 1923.) 18*s.* net.

A civil engineer laid the foundations of modern geology; it is therefore singularly inappropriate that civil engineers should be somewhat dependent upon the geologist for decisive opinions on the geological aspects of engineering schemes. The author would attribute the engineer's diffidence in the matter of geology to the air of specialisation with which an awesome nomenclature has invested the subject. Engineers are themselves rather at fault in having allowed the cloak of William Smith to descend on others' shoulders. The geology of field operations involves little more than a common-sense application of first principles to special types of observations made on the engineer's own ground.

Geology is now, however, a subject studied by most engineering students, who are well equipped for the study. The author's purpose is to induct civil engineers to a territory which they might have shared equally with geologists from the first, and this purpose is achieved in an inspiring book; it deals in a thoroughly practical way with geology from the engineer's point of view, and is in no sense a slender original design erected on a trimmed mass of material quarried from other works—the author's published work excepted. A brief introduction leads directly to the problems of water supply (Pt. I.); Pt. II. deals with field operations, Pt. III. with building materials. From first page to last the book bears the stamp of experience and practical acquaintance with engineers' problems. Illustrations include sketches taken from the author's field notebook; that a few of these are truly "sketchy" is less a defect than a positive merit, which the engineer will promptly recognise. Criticism can be directed only against their scale. These sketches are supplemented by numerous structural sections and photographs.

Assuming the reader is not familiar with geology, the conventional methods of representing the commoner rock types should receive early mention; the need for the "key" is urgent in Figs. 13-18; it is first given in Fig. 24. Similarly the terms strike, anticline, etc. which are freely used in Pts. I. and II. are defined in Pt. III., and rock classification is attacked before rock-forming minerals have been described. The author outlines a new scheme of rock classification which will

appeal to petrologists no less than to engineers. The inclusion of nephelinite under syenites is a slip which, with a few others, will doubtless be corrected later.

A. B.

An Advanced Course of Instruction in Chemical Principles. By Arthur A. Noyes and Prof. Miles S. Sherrill. Pp. xviii+310. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1922.) 18*s.* net.

PROFS. NOYES and SHERRILL have produced a work which might be mistaken at first sight for yet another text-book of physical chemistry, since it deals with such subjects as vapour-pressures, osmotic pressures, electrolysis, chemical equilibrium, chemical change, and the phase rule. A closer study of the book reveals the fact that it is quite distinct, both in its purpose and in its method, from the ordinary text-books of descriptive physical chemistry. This contrast is shown not only by what the book contains but also by what it omits. Thus, the newer theories of the structure of atoms, molecules, and crystals have been reluctantly omitted, in spite of their interest and importance, since on the chemical side they are mainly empirical, the general principles (if any) on which they are based being mathematical and physical rather than chemical.

A clear view of the purpose of the book is obtained by studying the series of problems which it contains. These are not merely supplementary to the course of instruction but are its most important feature. The total number of these problems is nearly 500; but suggestions are given for a shorter course when the time available is too short to cover the whole of the syllabus. In some respects the book recalls Nernst's "Theoretical Chemistry," although it is in some ways a more attractive book for the student. Thus the whole of the text is contained in less than 300 pages; and the English student has the advantage of reading it in the original language instead of in a translation. From the point of view of the teacher of chemistry, the problems on which the book is based are of importance as ensuring that the student really understands what he is being taught, and is able to apply it in a direct way to chemical problems. It is indeed difficult to imagine any course that would be of more value to the student of physical chemistry in enabling him to secure a real mastery of his subject; and this fact more than compensates for the absence of the more popular features which can be used to add to the attractiveness of a descriptive text-book.

Studies in Religion, Folk-lore, and Custom in British North Borneo and the Malay Peninsula. By I. H. N. Evans. Pp. viii+299. (Cambridge: At the University Press, 1923.) 20*s.* net.

MR. EVANS, now curator of the Taiping Museum, includes in this book notes collected during two series of explorations. The first part describes his investigations in the Tuaran and Tempassuk districts of North Borneo; the second deals with the customs and beliefs of the woolly-haired Negritos, the wavy-haired Sakai, and the Jakun pagans of the Malay Peninsula. This latter may be regarded as a supplement to Messrs. Skeat and Blagden's "Pagan Races," and Mr. Skeat's "Malay Magic." In North Borneo the coast districts are occupied by the Bajaus and Illanuns, proto-Malayans, but the Dusan pagans of the interior naturally attracted Mr. Evans's special attention. He gives an excellent description of the beliefs and customs of this interesting race. Much of his account of their religion, folklore and customs, and of head-hunting, now happily obsolete, may be compared with the records of other explorers in these regions.

The method of Mr. Evans wins our confidence. He gives the actual notes of his work and the sources of his information, without any attempt at generalisation, which is particularly dangerous when dealing with isolated communities where the culture varies from one valley or jungle to another. Even in the Malay Peninsula he has been able to add something to the harvest already garnered by Messrs. Skeat and Blagden. The folk-tales are mostly concerned with animals and their ways, and supply interesting parallels to those current in adjoining regions.

The Elasmobranch Fishes. By Prof. J. F. Daniel. Pp. xi+334. (Berkeley: University of California Press. 1922.) 4.50 dollars.

As the author reminds us in his preface, of all living fishes the Elasmobranchs are by far the most interesting and important for the understanding of the Vertebrata. In this handsome and beautifully illustrated volume Prof. Daniel gives a general account of the sharks and rays chiefly from a morphological point of view, though not neglecting the relation of structure to habits and food. Each of the eleven chapters dealing with the external form and the anatomy of the various systems of organs begins with a very clear description of *Heptanchus maculatus*, followed by a comparison with other more specialised forms, and concludes with an adequate bibliography. Thus the reader is presented with an excellent survey of the range of structure presented by the whole group. Matters of fact are very accurately stated, but in dealing with theoretical deductions of a more general nature, the author seems to be on less certain ground. One serious blunder only have we met, on p. 309, where the kidney tubules are called "nephridia." Surely it is now recognised that these tubules, derived from the cœlomic wall, have nothing to do with the true nephridia of Amphioxus and the cœlomate Invertebrates, but are rather to be compared to the cœlomoducts so constantly found in the latter? Prof. Daniel is to be congratulated on having produced a most instructive and attractive book which should prove useful both to students and to teachers of zoology.

The Story of the Maize Plant. By Prof. P. Weatherwax. (University of Chicago Science Series.) Pp. xv+247. (Chicago: University of Chicago Press; London: Cambridge University Press, 1923.) 1.75 dollars.

THIS volume serves to gather together in a convenient form much of our scattered knowledge of the maize plant, and provides a concise summary of the general history of this important food and forage crop. The accounts of the morphology, anatomy, and ecological relations of maize lead up to an exposition of methods of cultivation and harvesting, followed by a detailed description of the flowering organs and the development of the grain or seed. The author indicates the

great possibilities of improvement in quality of seed that might be brought about by a judicious application of the principles of plant breeding.

Maize would appear to have been much valued in aboriginal America, but with the great increase in colonisation which followed the voyage of the *Mayflower* it has steadily increased in importance until now the United States produce three-quarters of the total world-crop.

A special feature of the book is the excellence of some of the original text figures, which are both clearly drawn and well reproduced, being among the best hitherto published for this plant. The aim of the book, with others in the same series, is to reach the educated layman as well as the specialist, and the volume offers a useful and interesting résumé of the subject dealt with.

Supplying Britain's Meat. By G. E. Putnam. Pp. 169+16 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1923.) 5*s.* net.

Mr. G. E. Putnam is the consulting economist to Swift and Company, Chicago. Of the seven chapters of his book, the first three, and possibly the sixth, deal with the subject selected for the title of the book. The remainder are devoted to an economic justification of the big-scale United States businesses dealing with the distribution of meat and meat products, and to a defence of their conduct as stated in the official reports of American commissions, and the large volume of unofficial criticism from the American public.

From the British point of view, the most significant fact is that only 60 per cent. of the beef, and 50 per cent. of the mutton consumed in Great Britain is home-grown, and there seems little possibility of the home supplies even maintaining this proportion in the future. The manner in which this deficiency in home supply has been met by Imperial and foreign shipments is very well traced out. The sections dealing with the distribution of imported meat contain a detailed defence of the middlemen. The author believes that they perform indispensable economic functions, and further, their work cannot be done efficiently unless they are units in an organisation in the closest touch with the firms of meat exporters.

Letters of a Radio-Engineer to his Son. By John Mills. Pp. vi+265+12 plates. (London: G. Routledge and Sons, Ltd., 1922.) 10*s.* 6*d.* net.

At the present time practically every student at a technical college, and most school-boys, are intensely interested in radio communication. The author takes advantage of this and writes a book in familiar language as an introduction to understanding the latest developments of the art. He expends no time in describing fluid theories or pith balls. He plunges at once into describing protons and electrons and, provided his reader consents to follow him, shows what an essential part they play in radio apparatus. How to measure an "electron-stream" and "electron-moving-forces" are simply described. Inductance and capacity, tuning and resonance and the harmonics in the human voice are explained. Broadcasting stations, trans-Atlantic telephony and the telephone circuit with its amplifying stations connecting New York and San Francisco are also described. The author, who is a well-known expert of the Western Electric Co., concludes by pointing out how excellently ordinary telephony and radio telephony can be united so that the voice vibrations can be carried over wires and across wide spaces before they come to the receiver. The two methods use the same general principles and much of the apparatus used is common to both.

Epping Forest. By E. N. Buxton. Ninth edition revised. Pp. xiv+182+6 maps. (London: Edward Stanford, 1923.) 2*s.* 6*d.*

The ninth edition of this little book, which has been out of print since 1915, is very welcome. It contains a history of Epping Forest, with an account of the topography, accompanied by several coloured maps. Other chapters follow on the animals, birds, insects and pond life of the forest area, as well as the trees, flowering plants, mosses and fungi. A short chapter gives an account of prehistoric man and the animals he hunted. Another is devoted to the geology of the district. A final chapter has been added on the management of such a forest. It will no doubt be found useful by students, naturalists and others who visit Epping Forest and wish to know more of its natural history.

The Chemistry of the Inorganic Complex Compounds: an Introduction to Werner's Co-ordination Theory. By Prof. R. Schwarz. Authorised translation by Dr. L. W. Bass. Pp. x+82. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 8*s.* 6*d.* net.

This book is a translation from the German of an introduction to the study of co-ordination compounds. It is an excellent little book for the purpose, and even advanced workers in this branch of chemistry will find it of value on account of the fact that a reference to the original literature is given in the case of all the compounds that are referred to throughout the book. The form in which the book is issued is very attractive, and it should have a large circulation among English readers.

Handbook of Steel Erection. By M. C. Bland. Pp. ix+241. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 12*s.* 6*d.*

There are but few books dealing with this subject, and for the most part treatises on structures do not give adequate treatment to the methods of erection. The volume before us gives both descriptions of these methods and also the calculations involved in determining the strengths of the appliances used. Civil engineering students will find the book a useful supplement to their text-books on structures.

The Unconscious: an Introduction to Freudian Psychology. By Israel Levine. Pp. 215. (London: Leonard Parsons, Ltd., 1923.) 7*s.* 6*d.* net.

An excellent short account of the Freudian theory in its general philosophical aspect. The author finds no need to force on the reader unpleasant descriptions of particular neuroses, and he treats the whole concept of the unconscious as a metapsychology. Its relation to older classical conceptions and to modern rival theories is briefly but quite clearly indicated.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

X-rays and Crystal Symmetry.

MR. T. V. BARKER directs attention (NATURE, October 6, p. 502) to the difficulties that may arise in the classification of crystals in consequence of the use of the X-ray methods of analysis, since the latter take note of features in crystal structure which are not always the same as those from which the older methods draw their deductions. From the same point of view he discusses also the existence of the molecule in the crystal.

It is to be remembered that all inquiry must be directed to the determination of the relative positions of the atoms and the molecules within the unit of pattern, and of the forces which they exert on one another. The nature of the symmetry of the crystal and the possible existence of the molecule are questions of academic interest only, except in so far as they contribute to this end. From this point of view the difficulties described by Mr. Barker seem to lose much of their importance.

The symmetry determinations of the older and well-known methods are complete when the crystal has been assigned to one or other of the thirty-two classes: and this can generally be done, though there often remains some uncertainty. On the other hand, the X-ray methods determine the form and size of the unit of pattern and the number of molecules which go to the making of it. It is an open question which only experience can answer, whether the X-rays give absolutely correct evidence on this point: whether, for example, they might overlook some difference which, repeated at some multiple of the spacing determined by the rays, implied a larger unit of pattern. The difference might be of such a kind as to be incapable of detection however great it might be, or it might be missed merely on account of insufficient magnitude. So far, the evidence points to the possession by the X-rays of the power to detect any material difference: they can, for example, make apparent the difference between two neighbouring atoms of carbon in the diamond which are due only to differences in the orientation of their attachments to their neighbours. Moreover, the X-rays give such information as to the relative positions of the atom-groups into which the crystal unit may be divided that the crystal can not only be assigned to its proper class, but also to its proper type among the two hundred and thirty possible types of structure, as defined either by the space group of symmetry movements which the crystal possesses or by the arrangement which the X-rays have found. There is only one exception of importance. The X-rays cannot in general determine whether a crystal has or has not a centre of symmetry: and this sometimes leaves the alternative as to whether a crystal belongs to a certain type of symmetry in a lower class or to another type in a higher class obtained from the lower by adding the centre of symmetry. If it is known from observation of form or otherwise whether there is or is not a centre of symmetry the ambiguity disappears.

The general arrangement of the molecules having been found, any further observations of the form or other physical properties of the crystal have a value not because they may put the crystal up or down by a whole class, but because they help in the interpretation of the structure as it has so far been discovered.

So far as present experience shows, the atom group referred to above has the same composition as the chemical molecule: though it is not to be expected that it should have exactly the same form. In rock salt it is possible to associate with the sodium atom any one of the six chlorine atoms that surround it and to say that here is the molecule: or it may be said, if preferred, that the molecule has disappeared. In an organic crystal, naphthalene for example, there is one atom group which may with some justice be described as the molecule. Even here, however, many of the carbon atoms have two hydrogen neighbours, one of them belonging to the molecule to which the carbon atom belongs, and one to a neighbouring molecule. Is there any difference in the nature of the attachment of the carbon to the two hydrogens? If there is, then there is definitely something which may be looked on as the molecule since there is a group which has the same composition as the free naphthalene molecule and would actually form such a molecule on the dissolution of the crystal, though the shape might be slightly changed. If not, then it might be said, as of the diamond, though to a lesser degree in this case, that the whole crystal was one molecule. The position of the hydrogen would be an example of "co-ordination." The nature of the hydrogen attachments is obviously of the highest importance; and we may hope to learn more about it by further experiment. Only in that light, however, is there any interest in discussing the question of the existence of the molecule in the naphthalene crystal.

W. H. BRAGG.

The Optical Spectrum of Hafnium.

IN our letter to NATURE of March 10, 1923, we gave a preliminary list of the most prominent lines between 2500 and 3500 Å. U. in the arc spectrum of the new element hafnium, discovered by Coster and Hevesy (see NATURE, January 20, February 24, April 7, 1923). In this list we included only lines of intensity of 2½ and more, using a scale of intensity from ½ to 6. Prof. Hevesy has now been able to supply us with a pure hafnium preparation containing according to X-ray analysis not more than about 1 per cent. zirconium, and in addition small traces of titanium, manganese, and niobium. With this preparation we have photographed both the arc and the spark spectrum of hafnium. As to the arc spectrum, we have controlled all our older measurements of the published lines, and also of the weaker unpublished lines, and have added to these a considerable number of still weaker lines.

The spark spectrum does not seem hitherto to have been examined. On the other hand, Bardet (*Comptes rendus*, t. 176, p. 1711, 1923) a short time ago published a list of lines belonging to the arc spectrum of hafnium in the region between 2300 and 3500 Å. U. As it is not stated and cannot be inferred whether his lines are given in the international or in the Rowland scale, it is sometimes difficult to decide whether a line in his table coincides with one of our lines or not. As all his lines with the exception of 6 are stated as "moyenne," "faible," "extrêmement faible," "à peine visible," we think that his preparation was not very concentrated. As a whole, the two spectra are not very different; yet Bardet does not find all the stronger lines given in our first table, which (with one exception) are now all confirmed, and the relative intensity of his lines are rather different from ours. This seems to indicate that the hafnium spectrum can

differ much according to the conditions of excitation. This also, as is well known, is the case with the zirconium spectrum.

The spectra were photographed with the same instrument as before, and the arc spectra were produced in the way previously described; the spark spectra were obtained with a large induction coil between carbon electrodes saturated with the hafnium salt solution. In the table above we give the hafnium lines in international Å. U. in air measured against iron normals, and an estimation of their relative intensity I, both in the arc and in the spark spectrum (scale ½ to 6, lines weaker than 1 omitted; 6 denotes very strong, 5 strong, 4 rather strong, 3 not strong, 2 faint, 1 weak, ½ extremely weak, *d* diffuse). The wave-lengths are given to 0·05 Å. U., the accuracy which is generally reached; at the longer wave-lengths an error of about 0·1 Å. U. may be possible. Where (Ti), (Mn), (Nb), or (Zr) is added it means that the line in question is nearly coincident with a line belonging to the spectrum of one of these elements, traces of which we have mentioned were present, but that the line is so much stronger relative to the other lines of that element present in the spectrum that it is almost certain that the line really belongs to the hafnium spectrum.

λ.	I.		λ.	I.		λ.	I.		λ.	I.	
	Arc.	Spark.		Arc.	Spark.		Arc.	Spark.		Arc.	Spark.
2497·00	5	5	2713·45	½	1	2918·60	5	4	3156·65	5	5
2500·75	3	4	2713·85	4	3	2919·55	6	6	3159·80	5	5
2502·65	4	3	2718·55	5	5	2924·60 (Zr)	3	3	3162·60 (Ti)	5	6
2510·40	–	2	2727·40	3	2	2926·40	1	3	3172·95	5	6
2512·70	6	5	2729·10	4	3	2929·60	6	5	3174·90	1	1
2513·00	6	5	2731·10	1*d*	2	2929·90	4	4	3176·85	6	6
2515·50	4	4	2735·05	–	1	2940·25	1	2	3179·50	1	2*d*
2516·85	6	6	2737·80	3	2	2940·80	5	5	3181·00	4	4
2517·85	1	2	2738·75	5	6	2944·70	4	4	3189·70	4	4
2521·45 (Nb)	3	4	2743·60	4	3	2947·15	3	4	3193·50	5	5
2531·15	5	5	2751·85	5	5	2950·70	5	5	3194·20	6	6
2532·10	–	1	2756·90	3	4	2954·20	5	5	3195·60	2	2
2532·95	4	4	2761·65	5	4	2958·00	4	4	3200·00 (Ti)	4	5
2537·30	5	5	2762·70	4	3	2961·80	4	4	3202·15	1	2
2548·15	4	4	2764·55	½	1	2964·85	5	5	3203·70	3	4
2548·50	1	2	2766·95	4	3	2967·25 (Ti)	3*d*	4	3206·15	4	5
2548·95	–	1	2770·45	4	4	2968·85	6	5	3206·70	–	2
2549·10	–	2	2772·35	3	4	2973·40	–	3*d*	3217·15	5	5
2551·35	5	6	2773·00	3	3	2974·10 (Nb)	2	3	3220·60	4	5
2559·25	4	5	2773·40	6	6	2975·35	1	1	3226·95	2	3
2563·60 (Mn)	4	5	2774·05	5	4	2975·90	5	6	3230·10	3	2
2570·70	2	3	2775·25	4	3	2977·60	4	4	3243·40	4	2
2571·70	5	6	2779·35	5	5	2979·25	5	4	3249·50	4	3
2572·95	1	2	2784·50	½	1	2980·80	5	5	3253·70	6	6
2573·90	5	5	2786·30	3	4	2982·70	5	4	3255·30	5	6
2574·90	1	2	2808·00	5	5	2984·05	–	3	3262·55	3	3
2576·80	5	5	2809·60	1	1	2990·80	–	3	3267·10	5	3
2578·15	5	5	2812·30	2	2	2992·00	–	1	3280·00	5	5
2582·50	5	5	2813·85	4	4	3000·10	5	5	3283·40	5	3
2591·30	5	5	2814·45	4	4	3001·85	1	2	3289·70	1	1
2595·55	1*d*	2	2814·80	3	3	3011·20	2	3	3291·05	4	3
2599·15	1	2	2816·10	1	2	3012·85	6	6	3294·55	–	1
2602·65	3	3	2817·70	5	3	3016·75	6	5	3298·95	3	2
2602·85	3	3	2818·95	4*d*	3*d*	3018·30	5	5	3309·25	4	3*d*
2606·40	5	5	2819·75	4	3	3022·05	–	2	3310·25	5	4
2607·00	5	5	2820·20 (Ti)	6	6	3024·70	–	4	3310·90	1	3*d*
2607·25	2*d*	2	2822·70	6	6	3025·30	–	4	3312·85	6	6
2608·40	3	3	2829·30	3	4	3031·15	5	6	3317·20	½	1
2609·95	3	2	2833·30 ?	5	4	3034·55	2	1	3317·95 (Ti)	5	6
2612·55	3	2	2834·15	4	3	3046·05	4	4	3324·15	½	2
2613·60	4	5	2845·80	5	5	3050·75	5	4	3328·15	5*d*	5
2614·25	1*d*	2	2849·20	5	5	3054·50	4	3	3332·70	6	6
2616·60	4	3	2850·10	3	3	3055·45	4	3	3352·00 (Ti)	6	6
2620·90	1	2	2850·90	4	3	3057·00	5	5	3358·90	5	3
2622·70	6	6	2851·20 (Ti)	5	4	3067·35	6	5	3360·05	4	3
2626·90	3	4	2857·65	4	4	3069·15	3	3	3366·70	4	2
2635·75	3	4	2858·70	1	2	3072·90 (Ti)	6	5	3378·90	4	3
2636·95	4	3	2860·30	1*d*	3	3074·10	3	3	3384·15	1*d*	3*d*
2638·70	6	6	2860·55	3	3	3074·80	4	4	3384·65	5	4
2641·40	6	6	2861·05 (Nb)	5	6	3076·85	2	3*d*	3386·10	4	4
2642·70	5	3	2861·70	6	6	3080·75	6	6	3389·80	5	5
2647·25	6	6	2863·35	3	2	3091·75	1	2	3395·00	3	4
2649·10	3	4	2866·35	6	6	3092·25	4	4	3397·50	4*d*	3*d*
2652·30	1	2	2867·75	1	2	3096·75 *	5	4	3399·80	6	6
2652·75	3	2	2873·65	3	2	3100·75	–	1	3402·45 (Ti)	4	3
2657·45	4	4	2876·35	5	5	3101·40	6	6	3407·75	4	4
2657·80	5	5	2879·10	4	4	3102·45	–	1	3410·15	5	6
2661·85	5	5	2885·50	3	4	3109·10	6	6	3412·35	3	1
2665·95	5	5	2887·15	4	4	3114·85	–	1	3413·75	5	3
2668·25	4	3	2887·55 (Ti)	4	3	3116·95	3	4	3417·35	5	3
2669·00	5	4	2889·60 (Mn)	5	5	3119·95	4	4	3419·20	5	4
2671·20	3	4	2892·55	4	3	3123·90	1	1	3428·40	5	5
2676·55	2	3	2894·00	–	1	3126·30	2*d*	3	3438·25	6	6
2677·55	2	3	2894·85	1	1	3128·75	3	3	3441·85	3	2
2678·35	1	2	2898·25	6	5	3131·80	–	5	3462·65	4	4
2683·35	5	6	2898·75	5	4	3134·75	6	6	3467·60	3	2
2685·15	3	4	2904·40	5	5	3137·55	3	3	3472·40	5	5
2688·35	2	1	2904·80	5	5	3139·70	3	4	3479·20	6	6
2697·05 (Nb)	2	2	2909·85 (Ti)	5	5	3140·75	3	4	3487·55	½*d*	3
2703·15	1	2	2912·75	1	1	3145·30	5	6	3495·75 (Ti)	5	5
2705·60	6	5	2913·15	½	1	3148·45	4	4	3497·40	5	5
2706·70	6	5	2916·50	6	5	3151·65	4	3	3505·20	6	6

* In our former letter erroneously given as 3097·75.

A similar examination of the hafnium lines in the remaining part of the spectrum which is obtainable photographically, will appear shortly. We publish this table first, because it comprises the region in which high accuracy is easily reached by smaller spectrographs, and will therefore mainly be used for identification, as the hafnium spectrum shows few characteristic lines in the visible part of the spectrum.

H. M. HANSEN.
S. WERNER.

Universitetets Institut for teoretisk Fysik,
Copenhagen, September 20.

The Isotopes of Lead.

IT was suggested by the writer in 1912 that the end-products of the uranium and thorium disintegration series should differ in atomic weight from that of common lead, which chemically they closely resemble. As the atomic weights of these products, determined experimentally later by Richards and others as approximately 206 and 208 respectively, "bracketed" the atomic weight of common lead, it was not unreasonable to suppose that common lead is a mixture of isotopes of which the mass-numbers 206 and 208 are chief. This, although probable, is still unproved. The further deduction that conceivably lead in Nature has been mainly produced by the disintegration of uranium and thorium has received some, but not a great measure of support. If it could be shown experimentally that common lead has some isotopes which are not likely to be produced by disintegration, this hypothesis would be more difficult to maintain; if the difference were complete the hypothesis would be disproved.

My analysis of the complexity of elements, of which some account was given in NATURE of October 20, leads logically to the conclusion that common lead consists principally of mass-numbers 204, 205, 206, 207, 208, and 210, of which probably 206 and 208 are chief. This is surprising since the mass-numbers of isotopes do not differ generally by more than 8 units, and radium B weighs 214. Most of these numbers may also be derived from Aston's published results for the isotopes of elements 18, 34 and 50, the atomic numbers of which, like lead, are of the form $16n+2$. In addition, the mass-numbers 205 and 207 are deducible from this consideration: an element of even atomic number z may have an isotope of odd mass-number a apparently only when the difference $a-2z$ is unique. The differences 3, 5, and 7 do not appear to belong to any element,

but 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, and 39 may be most probably assigned to elements 34, 36, 44, 48, 50, 50, 54, 54, 60, 64, 66, 66, 70, 70, 76, and 80 respectively. (The results for elements 34, 36, 50, 54, and 80 are Aston's.) If this be accepted, it follows that the differences 41 and 43 belong to element 82, because (*a*) the mass-number 201 appears to be unstable (being the head of a series of unstable mass-numbers 201, 157, 113, 73, and 33), and therefore 41 cannot be assigned to element 80; and (*b*) because it is to be expected that element 82, like 66 and 50, has two odd isotopes. These are in consequence 205 and 207.

Of the six isotopes mentioned above, 206, 208, and 210 are end-products of radioactive series; possibly 207 is also; so that this analysis, if confirmed experimentally, cannot by itself claim to dispose of the view that common lead may be of radioactive origin. But neither does it necessarily support it; the matter is still left open.

It is not unlikely that the odd mass-number 205 is an isobare, because thallium ($z=81$) is likely to consist of mass-numbers 203 and 205, not only because its atomic weight lies between these numbers but also from the analysis in my last letter. Aston, by showing that mercury has probably an isotope of 197, first established the possibility of the existence of odd isobares in the inactive elements, since it is very probable that gold's principal isotope is 197 also. But, in general, odd isobares are likely to be rare among inactive elements, but not impossible, as I said.

Neodymium, dysprosium, and ytterbium were not mentioned in my last letter. The chief isotopes of the first of these appear to be 142, 144, 145, and 146, possibly 148 and 150 also; of the second, 160, 161, 162, 163, 164, and possibly 166; and of the third 172, 173, 174, 175, 176, and possibly 178. I should like also to make a few minor alterations to previous statements. Lanthanum is apparently not simple but includes (possibly very little of) 137; gold is not likely to have 199; holmium is mainly 165. Tellurium should contain 122. But as I have now been able to calculate simply both unstable mass-numbers and even isobares, details are not of first importance.

It is not asked that any of the mass-numbers of this or of the previous letter should be accepted before being disproved or confirmed by experiment. But they are of interest as being the most probable numbers obtained by a simple and straightforward consideration of the facts of radioactivity on the reasonable assumptions stated.

A. S. Russell.

Dr. Lee's Laboratory, Christ Church, Oxford, October 13.

Problems of Hydrone and Water: the Origin of Electricity in Thunderstorms.

Prof. Armstrong's friendly criticism (Nature, October 13, p. 537) of my theory of the origin of electricity in thunderstorms seems to neglect the fact that my explanation of thunderstorms is based entirely upon experimental and observational evidence. If experiments can be said to prove anything, then my work and the work of others has shown conclusively that: (*a*) if there are ascending currents exceeding 8 metres per second in the atmosphere, there must be a great deal of breaking of rain drops; (*b*) every time a water drop breaks there is a separation of electricity; (*c*) the broken water drops retain a positive charge; (*d*) the air attains a negative charge. On the other hand, observations have shown that there is a considerable excess of positive electricity brought down by rain. These are all tangible facts which any one can test by making the suitable experiments, and I have done nothing more than arrange them into such a form that a reasonable account of the phenomena of thunderstorms results.

Surely Prof. Armstrong does not wish to suggest that all this work is wrong because it does not fit in with his theory of hydrones. He cannot expect us to neglect the evidence that electricity is produced when drops break, because, according to his theory, it appears more likely that electricity would be produced when drops combine.

What alternative has he to offer to a theory which has met with very wide acceptance? He says: "Assuming that my interpretation be correct, may not the great rise in potential required to produce lightning have its origin in the coalescence or cooperation of minute drops charged by an external source?" This is very depressing, for it throws us back to where we were twenty years ago, with an unknown "external source" of electricity and erroneous ideas of the increase in the potential of a cloud due to the coalescence of the drops.

G. C. Simpson.

Meteorological Office, London.

The Occurrence of Urease.

Letters on the occurrence of urease are printed in Nature of August 11 and September 22. In the former, Prof. Werner reports that he has found urease in all the leguminous nodular growths he has tested; in the latter, Prof. Beijerinck describes how he has detected the enzyme in *B. radicicola*. Prof. Werner writes: "So far as we have been able to ascertain, the peculiar root nodules of leguminous plants have not hitherto been tested for urease." I reproduce, therefore, the following passage from an article on "The Function of Hormones in regulating Metabolism," by my son and myself, published in the *Annals of Botany*, vol. xxv., No. xcviii., April 1911.

"Lastly, we may refer to the nodular growths on the roots of leguminous plants; these are known to be most essential to the proper growth of the plant but their function is by no means clear; it is well known that they are the seat of bacteroids and it may be that these function as assimilators of atmospheric nitrogen gas and convert it into ammonia; or it may be that they exercise digestive functions and serve to 'deamidate' amino-compounds. At all events, they are distinctly alkaline, whereas the root sap is acid. Moreover, it has been shown by Hutchinson and Miller, that, when distilled with magnesia under reduced pressure, the nodules furnish more ammonia than do the roots (0·043 per cent. against 0·016 per cent.). We suggest that some part at least of the influence exercised by the nodules may be due to their aminogenetic power. We propose to make this assumption the basis of experimental inquiry."

Then, I would direct attention to the British Association Report, Australia, 1914, where, at p. 109, the following passages are to be found, at the end of the Report of the Committee for the Study of Plant Enzymes.

"In view of the presence of ammonia in the nodular growths appearing on the roots of Leguminosæ, it appeared probable that the enzyme Urease would be found in these. It has been detected in the nodules from Lupins and a number of other Leguminosæ. Attempts to detect the enzyme in organisms cultivated from the nodules have thus far been attended with negative results.

"Mr. Benjamin, working at Hawkesbury Agricultural College, near Sydney, Australia, has detected urease in nodules from several Australian plants, including wattles; also on tubercles derived from the

Cycad, *Macrozamia spiralis*. He has found urease also in the seeds of *Abrus precatorius*."

The earlier experiments referred to were my own. Mr. Benjamin had assisted Mr. Horton and me in our work on urease, published early in 1913. He was a young Australian and he undertook the observations, on his return, at my request. When in Java, in September 1914, I had the opportunity, at the Buitenzorg gardens, of testing fresh Abrus seeds and of confirming Benjamin's result. I may say, the amount present is small, in no way comparable with that in Soja beans.

To me the presence of urease in the nodules is little short of a matter of course—in view of their "ammonicity." The interest of the observation lies in the possible application thereof.

Urea is foreshadowed as the nitrogenous fertiliser of the future but apparently it has its limitations. All soils, all plants, do not respond to it equally. I was told years ago, that it is particularly good for Pease. Why, Mr. Peasecod? Probably it is not operative as such but merely as a source of ammonia and must be hydrolysed to make it available. Only soils which contain urease would respond. A clover-sick soil may well be wanting in the organisms which give rise to the nodular growths.

To be practical—it would seem to be desirable to test the comparative effect of urea on the growth of non-leguminous plants when grown with and without a leguminous plant, such as clover.

Henry E. Armstrong.

Colour Vision and Colour Vision Theories.

In the first of my two recent letters on this subject I selected five of the cases in which Dr. Edridge-Green asserts that the trichromatic theory cannot explain certain phenomena of colour vision; and I indicated, in each case, the source of his error. In more than one case I gave the full proof. In his reply he took no notice of these proofs except in so far as he seemed to admit their accuracy. But he brought forward three other cases, asserting incompetence of the trichromatic theory in connexion with them. In my second letter (Nature, September 8) I similarly indicated the oversight involved in each of these three additional assertions.

I must confess, therefore, to some degree of surprise that Dr. Edridge-Green, in his letter appearing in Nature of September 29, should say that he will deal with my explanations regarding the competence of the trichromatic theory when I give them. They are already given, and I shall be glad if he will discuss them. To make the matter definite, I invite him to discuss the trichromatic explanation which I have given, in my first letter, of the case of so-called red-blindness with shortening of the spectrum at the red end. The proof is fully given. Another proof, fully given in geometrical terms, is that dealing with the possible diminution of colour sensitiveness by the annulment of one component sensation.

Instead of discussing any of the eight explanations which I have already given either in full or in outline, Dr. Edridge-Green now points out that he is not alone in regarding the trichromatic theory as inadequate. Unfortunately, misunderstanding of the theory is too regrettably widespread for the reason which I expressed in my first letter. If any reader who is interested in the matter will refer to the discussion which I have given in my book he may recognise that the statement referred to in Dr. Edridge-Green's last letter, concerning contrast and colour blindness, is not correct. It cannot be discussed in the scope of a short letter.

I appreciate Prof. Frank Allen's work greatly. The difficulty to which he refers vanishes, as I am sure he will readily recognise, when the three variables (threshold values) descriptive of non-external action are considered. In fact, in the whole field of contrast, after-images, recurrent images, and inhibition, the trichromatic theory has at its disposal a *double* set, not a single set, of three variables. Such work as that of Prof. Frank Allen is of great importance in view of the need of a formulation of the threshold values as functions of precedent illumination, time, secondary stimuli, etc. His early work, long ago, led me, in attempting something different, to full recognition of the sufficiency of the trichromatic theory.

What blindness must have oppressed the mental vision of Helmholtz, "that investigator, worthy of wonder, leaping before his time," if it were true, as Dr. Edridge-Green asserts, that "There is no fact that directly supports the trichromatic theory." Which Helmholtz elaborated so as to fit facts, and used victoriously to predict others! I know of none that fails to support it. I have studied Dr. Edridge-Green's book very carefully, and I have not found one of his strictures upon the theory with which it was possible to agree. Even Sir William Abney, one of the supporters of the theory, whose experimental work was so admirable, was led to some wrong conclusions through non-perception of some of its possibilities.

W. Peddie.

Dundee, September 29.

Sexual Physiology.

In Nature of September 1, p. 317, under the heading "Sexual Physiology," a review appeared of the second edition of Dr. Marshall's book "The Physiology of Reproduction." In the course of this notice certain misleading statements are made regarding myself. The reviewer, in referring to the chapter of the work dealing with the subject of the fertilisation of the ovum, states, "The least satisfactory part of the book, both as regards arrangement and subject-matter, is, we think, that contributed by Dr. Cresswell Shearer on fertilisation."

May I point out that I am not the author of this chapter; while I have revised Dr. Marshall's manuscript, and added a number of notes here and there of minor importance, the two sections of which I am the author are clearly indicated in the footnotes, and I think are sufficiently obvious. In regard to that part of the chapter which has called forth the special criticism of the reviewer, "The hereditary effects of fertilisation," I am altogether unresponsible, although I completely agree with many of the opinions expressed by Dr. Marshall in this section. As the whole of this paragraph appears almost unaltered in the old edition, it would seem that your reviewer is by no means as familiar with the original work as he would have us believe.

C. Shearer.

A footnote to Chapter vi., "Fertilisation," states that this has been "Revised, with numerous additions, by Cresswell Shearer." It was assumed, from this, that Dr. Shearer had taken the chapter as it stood in the first edition and had made himself responsible not only for the numerous additions but also for the whole of the subject-matter of this chapter in the present edition, and for its presentation. That we are not alone in reading this meaning into the footnote is shown by the fact that another reviewer, writing elsewhere, states that "Dr. Cresswell Shearer has written in this edition a most excellent chapter on fertilisation." If Dr. Shearer did revise the chapter, then his objections are but

formal; but it would appear that he did not revise, as we understand the term, but merely read the manuscript, placing also at the service of the author certain discrete sections for possible inclusion. The footnote is misleading.

THE REVIEWER.

Numerical Relations between Fundamental Constants.

IN connexion with the letter from Dr. Ernest Dorsey in NATURE of October 6, p. 505, it may be pointed out that most of the numerical relations which he describes are implied in the statement given in a paper in the Proceedings of the Physical Society of London (vol. 27, p. 425, 1915), that all units derived from e, m, and c can be expressed (with considerable accuracy) in the C.G.S. system in terms of simple integers (2, 3, or 4), powers of 10, q and π. Here q is a pure number, which represents the value of $2\pi e^2/hc$. This constant is the same as that employed in Sommerfeld's papers on the fine structure of spectrum lines, where it is denoted by α. If the relation of Lewis and Adams (*Phys. Rev.* vol. 3, p. 92, 1914) be accepted, the numerical value of q or α is $(15/\pi^2)^{\frac{1}{3}}/(4\pi)^2 = 7{\cdot}28077 \times 10^{-3}$.

Whether this be the correct value or not, the number represents one of the most important physical constants, and corresponds to a deep-seated relation between the ultimate nature of electric force and that of magnetic force. The quantum theory indicates the existence of discrete magnetic tubes of induction determined by the fundamental unit (h/e), and it has been suggested to me by Mr. W. H. Watson, of the University of Edinburgh, that the constant may be interpreted as giving the relation between a quantum magnetic tube and a unit electrostatic tube of force.

As regards the occurrence of integral powers of 10 in the expressions for physical constants, it must be remembered that the units of length, mass, and time in the C.G.S. system are not entirely arbitrary. The assumption is made that the gram is the mass of 1 c.c. of water at the temperature at which its density is a maximum, and the fact that the "molecular number" (Trans. Chem. Soc. vol. 113, p. 389, 1918) of water is 10 possibly accounts for the relations concerned. Dr. Dorsey includes the gas constant in his list, and here again the physical properties of water are involved through the definition of the Centigrade scale of temperature.

H. S. ALLEN.

The University, St. Andrews.

Insects in Korean Amber.

ON the morning of September 1 I saw a piece of carved amber, containing Diptera of several species, in the shop of G. M. T. De Silva in Yokohama. I was informed that it came from Korea (Chosen), but as the exact locality and geological horizon were unknown, and the price was rather high, I did not purchase it. At noon of the same day the earthquake occurred, resulting in the destruction of the whole of Yokohama, including De Silva's shop. I should be greatly interested to learn anything more about this Korean amber, the insects in which should be described. Some days earlier I saw in Mr. Y. Nawa's museum at Gifu a very fine lot of fossil insects, apparently of late Tertiary age. These have never been critically studied or described, but it is to be hoped that they will eventually be properly recorded. I could not discuss them with Mr. Nawa, as he knows no English, and no interpreter could be found at the time of my visit.

T. D. A. COCKERELL.

University of Colorado, Boulder, Colorado.

Tidal Dissipation of Energy.

IF g denote the intensity of surface gravity, ρ the density of water, and h the elevation of the water surface above its mean position, the potential energy of the oceanic tide is $\frac{1}{2}g\rho h^2$ per unit area. The kinetic energy must be comparable. If h has the equilibrium amplitude of 35 cm., the total energy of the ocean, the area of which is $3{\cdot}7 \times 10^{18}$ cm.^{2}, must be about $2{\cdot}2 \times 10^{24}$ ergs.

Now the mean rate of dissipation of energy by tidal friction is about $1{\cdot}4 \times 10^{19}$ ergs/sec. Thus the whole energy of the tides would be dissipated in about $1{\cdot}6 \times 10^5$ sec., or two days, if dissipation continued at its average rate and no new energy was supplied.

It follows that tidal friction in shallow seas must absorb so much of the energy in the tidal waves that reach these seas, that the lags of the tides in the open ocean may differ by some hours from those calculated on the usual assumption that the coasts may be treated as simple reflecting boundaries.

HAROLD JEFFREYS.

St. John's College, Cambridge.

Repellents of Clothes Moths.

IN NATURE of September 8, p. 376, appears a report of a lecture on "Plants in Relation to the Health of Man," in which Dr. A. W. Hill refers to the supposed property of camphor as a preservative of clothing against moth. Henri Fabre found camphor and naphthalene to have no effect upon moths, and I have found these insects utterly indifferent to such odoriferous substances. In fact, I doubt if they can smell at all. It would be interesting to hear of some definite experimental result bearing upon this point.

REGINALD G. JOHNSTON.

51 Belmont Hill, London, S.E.13.

SOMEWHAT surprisingly, no precise experiments with the object of discovering effective repellents of clothes moths, of which at least three distinct species occur in this country, appear to have been carried out by any one. Mr. R. G. Johnston is perfectly correct in regarding as devoid of any real foundation the popular belief in the efficacy of camphor as a preservative of clothing against moth, although there is no reason for supposing the insects in question to be deficient in olfactory sense. Naphthalene again, if merely scattered loosely in a drawer or wardrobe containing clothes, will certainly afford no protection whatever. On the other hand, naphthalene is quite satisfactory as a repellent if placed inside clothing which is afforded the additional protection of a wrapping of stout paper, the edges of which freely overlap, and are tightly secured by means of pins.

E. E. A.

Amanita muscaria on Hampstead Heath.

THE difficulty of obtaining a supply of this mushroom for scientific investigation is well known to physiologists and chemists. Its disappearance, except in unfrequented woods, is probably accounted for by its attractive colouring and its subsequent destruction as one of the most poisonous representatives of its family. Therefore its occurrence near London deserves to be put on record. A fine specimen, weighing 140 gm. and measuring 12 cm. in diameter, was brought to me for identification by Mr. H. C. Simmons, who found it, after the heavy rains of last week, on the West Heath in the low-lying ground between the North End and Spaniard's Roads.

O. ROSENHEIM.

75 Hampstead Way, London, N.W.11,
October 17.

Boskop Remains from the South-east African Coast.

By Prof. RAYMOND A. DART, University of the Witwatersrand, Johannesburg, South Africa.

THE controversy raging over the Piltdown remains, and the coming of the War shortly afterwards, were the two events which conspired to distract the attention of the scientific world from the significant discovery which was made in South Africa in 1913,

FIG. 1.—External view of the right parieto-occipital fragment of *Homo capensis*, showing the lambdoidal and sagittal sutures.

when a farmer unearthed some fragments of a human skull at Boskop near Potchefstroom in the Transvaal. Last year, the discovery of a more primitive human race in *Homo rhodesiensis* has served to redirect attention to the part which Africa still has to play in elucidating the wider questions of human origins and human migrations.

Since the time the bet between the two farmers as to the "humanity" of the Boskop remains was settled, Mr. FitzSimons, Director of the Port Elizabeth Museum, has been assiduously excavating the rock shelters in that neighbourhood. In June last he forwarded to the Department of Anatomy in the University of the Witwatersrand a consignment of skeletal material which contained the remains of several members of the ichthyophagous Strandlooper race which preceded the Hottentots along the coastal areas.

The Strandloopers, now extinct as a race, were the builders of gigantic kitchen-middens in South Africa. In the particular rock-shelter at Tzitzikama explored by Mr. FitzSimons, this material, in which the Strandloopers had been interred, was removed layer by layer to a depth of fifteen feet. At this level he came upon bones of an entirely different calibre and appearance. Recognising this fact and appreciating the possibilities of the discovery, he forwarded these specimens separately. Altogether, I have received remains of some five individuals from this site, and though mixed together and fragmentary they afford definite evidence that they belong to the same race as was found in the Transvaal in 1913.

Figs. 1 and 2, which illustrate the outside and inside views of part of the right parietal and occipital bones, demonstrate the thickness and texture of the cranial bones in this race. Fortunately, the fragment crosses the line of the sagittal suture (Fig. 1), hence the cranial form is accurately known. It reveals the same type of breadth, flattening, and central depression in *norma occipitalis* that was pointed out for Boskop man by S. H. Haughton.[1]

Fig. 3 shows the inner aspect of three other pieces which were found to articulate exactly along the line of fracture. The state of preservation and general appearance of the bones justifies the assumption that they form part of the left half of the cranium represented by our right parieto-occipital fragment. Fig. 4 is an external view of the same three bony pieces on a rough reconstruction of the endocranial cavity which errs, as I have since determined, on the side of generosity in volume.

So far as the evidence goes, the skull appears to be that of a woman; for other specimens (which I believe to be male) show a more marked glabella, more robust eyebrow ridges, and a greater development of the frontal lobes of the brain. The smallness of the mastoid process, the thickened and tuberculated inferior margin of the tympanic plate, and the very vertical forehead also corroborate its feminine character.

When the fragments have been oriented, the following provisional measurements are obtained: maximal length 210 mm., and maximal breadth 150 mm., as

FIG. 2.—Internal view of the right parieto-occipital fragment of *Homo capensis*, showing the thickness and texture of the cranial bones.

compared with the length of 205 mm. and breadth of 154 mm. secured for the Boskop calvaria. If this length be correctly determined, we are in the presence of the longest-headed human skull yet discovered. It was undoubtedly dolichocephalic.

The first estimations of its endocranial content seemed to show, on account of the extraordinary length, a figure even higher than that secured by

[1] "Preliminary note on the ancient human skull remains from the Transvaal." Trans. of the Roy. Soc. of S.A. Vol. vi. Pt. I. 1917.

Haughton (1832 cubic centimetres), and by Broom[2] (1960 cubic centimetres) for the Transvaal specimen; but after taking casts from the fragments and reconstructing the endocranial cavity, my endocranial cast gives a far smaller capacity—in the vicinity of 1750 cubic centimetres. This figure still reveals a capacity far in advance of the average for modern European brains (Meckel's brain capacity was only 1320 cubic centimetres and Raphael's 1420 cubic centimetres), and is the more striking when it is remembered that the skull is female. The other male crania indicate a greater capacity.

Concerning the Boskop endocranial cast Elliot Smith said, "Its features present a curious blend of those characters which are regarded as distinctive of Mousterian and Aurignacian types of men respectively; but whereas the general form presents certain resemblances to the former, in all essential respects the cast conforms to the type represented by the Cro-magnon man of Western Europe." Broom (*loc. cit.*) goes further and believes it not unlikely that the Boskop type was ancestral to both Neanderthal and Cro-magnon man.

Unfortunately, insufficient jaw remains exist to prove or disprove Broom's contention concerning the supposed massive mandible and large canines. On the whole, the delicacy of the facial skeleton of this specimen is in strong contrast with the massive build and thickness of the calvaria, and scarcely favours the expectation of massive jaws. On the other hand, the nasal process of the maxilla is relatively enlarged and plays an enhanced rôle in bounding the nasal aperture and wall—features emphasised by Boule ("Les Hommes fossiles") as indicating the *ultra-human*

FIG. 3.—Internal view of the three fragments of the left side of the skull of *Homo capensis*. The vascular arrangements are particularly well-marked.

character of Neanderthal man. The pithecoid nature of the small mastoid process, supra-mastoid ridge, mandibular fossa, and superciliary ridges in this type, features which once more link it to primitive Neanderthaloid forms, were emphasised by Haughton (*loc. cit.*). The same point of view is favoured by the relatively low development of the frontal lobes of the brain.

The endocranial cast of this specimen reveals further an extremely broad and depressed Sylvian fossa. The cast is sufficiently complete in this region to show that here the Sylvian depression was even wider and more patent than in the endocranial cast of the Mousterian man of La Chapelle, concerning whom Boule does not hesitate to say that the island of Reil was partially exposed. It seems that, in this respect, our Boskop woman was even more pithecoid. The sulcus lunatus also is prominently indicated in the right parieto-occipital fragment. Incidentally, it may be stated

FIG. 4.—External view of the three fragments of the left side of the skull of *Homo capensis* on a rough preliminary reconstruction of the endocranial cavity. Features to be noted are referred to in the text.

that the endocranial cast indicates a marked asymmetry of brain and skull, the right frontal pole and left occipital pole respectively being more expanded than their fellows of the opposite side.

While certain of the foregoing data betray primitive, if not even Neanderthaloid, features, the study of other skeletal remains favours the Cro-magnon affiliation. A complete femur (also apparently female) indicates by its length (461 mm.) a stature in the vicinity of 5 feet 6 inches, which is considerably above that of Neanderthal man; and the male stature was presumably more considerable. Its straightness and slender build (despite a tendency to the exhibition of a third trochanter, a fossa hypotrochanterica, and a high pilastric index) are also in strong contrast with that of Neanderthal man. The vertebral column in a male specimen in the lumbar region (3rd, 4th, and 5th vertebræ) gives a general lumbar index of 97·4, which indicates a marked lumbar curve (kyrtorhachism) such as is found in modern Europeans.

The more detailed study of the remains may throw clearer light upon a bizarre mingling of characteristics which, at the present time, is highly confusing. It may prove justifiable, as Broom is already convinced, to separate this human group from both Neanderthal and Cro-magnon man as a separate species (*Homo capensis*). There is no doubt, meantime, that these new human documents, which have been brought to light through the energy and enthusiasm of Mr. FitzSimons, have further emphasised the anthropological wealth of Africa, and the need for more cautious investigation of the deeper strata of our coastal rock shelters, with

[2] "The evidence afforded by the Boskop skull of a new species of primitive man (*Homo capensis*)." Anthrop. papers of the Amer. Mus. of Nat. Hist. Vol. xxiii., Pt. II. 1918.

the strictest observance of the methods of modern archæology.

Through this discovery we now know definitely that the Boskop race preceded the Strandlooper race historically. They perhaps owed their extinction to the latter, the Solutrian culture of which (so ably examined by Dr. L. Peringuey,[3] the Director of the South African Museum) indicates familiarity with the uses of the bow. We know further that the Boskop specimen was no human freak, but a type representative of a race once widely distributed in South Africa from the Transvaal to the remotest south-eastern corner of the continent.

The implements, culture, and æsthetic achievements of these big-brained men of pre-history still remain to be discovered. Their employment of ochre in their burial rites indicates their familiarity with pigments and the artistic and symbolical uses to which they might be put. The remarkable parallelisms between the so-called "Bushman" art and that of Cro-magnon man in Europe was insisted upon by Sollas many years ago, and the evidence may yet be forthcoming which will conclusively solve the fascinating yet elusive problem of their correlation.

[3] "The Stone Ages of South Africa," etc. Annals of the South African Museum. Vol. viii. July 5, 1911.

Insulin and its Value in Medicine.[1]

By Prof. J. J. R. MACLEOD, F.R.S.

CARBOHYDRATES are essential in the chemical processes upon which life depends. Not only is the glucose, the form in which they are mainly absorbed into the blood, the source of muscular energy, but it is also in some way necessary in the oxidation of fats. Preceding its oxidation, glucose undergoes a series of preliminary changes which proceed step by step in such a manner that a long series of intermediary substances is formed; and when anything interferes with the process at any stage, as in diabetes, glucose accumulates in the blood and tissue fluids, causing the main early symptoms of the disease, hyperglycæmia and glycosuria. Later involvement of the oxidation of fats results in the accumulation of the ketone bodies in the organism, and these, by their toxic action, cause the often fatal condition of coma.

The control of this process of carbohydrate metabolism has for years been assumed to be the function of a hormone derived from the Isles of Langerhans of the pancreas. Although the existence of this hormone was fairly certain, little success resulted from attempts to extract it in potent form from the pancreas, probably because it was destroyed by the powerful digestive enzymes also present in such extracts. Banting and Best circumvented these by making extracts of the degenerated residue of pancreas following ligation of the ducts, it having previously been shown that in this residue the islet cells are more or less intact but the external secretory cells are largely degenerated. The extracts were found to remove the two chief symptoms of diabetes in depancreatised dogs. Alcoholic extracts of adult beef pancreas were also found to contain the hormone, and by their continued use it was possible considerably to prolong the life of the diabetic animals. J. B. Collip then succeeded by fractional precipitation with alcohol in ridding these alcoholic extracts of irritating substances, so that they could be repeatedly injected into diabetic patients.

With larger supplies of insulin available, it was now possible to show that it removes all of the observable symptoms of diabetes in depancreatised dogs. Thus, not only did it cause glycogen to become deposited in large quantities in the liver when sugar was fed to the animals, the first analysis giving more than 20 per cent. of this substance (J.B.C.), whereas without insulin traces only are found, but it also caused the respiratory quotient (ratio between CO_2 and O_2 in respired air) to become raised. These results were soon confirmed on diabetic patients. In more recent work, in which depancreatised dogs were given insulin daily along with considerable quantities of carbohydrate, life has been prolonged for over four months, and by careful comparison of the sugar balance of the animals it has been found, by F. N. Allen, that a small amount of insulin is capable of causing relatively much more glucose to be metabolised than when a large amount is given. Or, in other words, the glucose equivalent per unit of insulin is much higher with small than with large doses.

Although there can be no doubt of the high therapeutic value of insulin in the treatment of many cases of diabetes, its value as a new instrument for the investigation of problems of metabolism other than those relating to this disease is also high. Evidence for this belief is founded, among other things, on the striking effects of insulin on normal animals. When it is administered to rabbits, for example, the first effect is a very rapid lowering in the percentage of sugar of the blood—first observed by J. B. Collip—and when this reaches a certain level symptoms of a peculiar nature supervene. These consist usually of violent convulsive seizures each lasting for a minute or so, and of a gradually increasing state of coma, with fall in body temperature, ending often in death from respiratory failure. Symptoms of a similar character occur also in other animals, including man, after large doses of insulin.

The symptoms were found to be dependent on the lowering of blood sugar; thus, they usually supervene in normally fed animals when the blood sugar has fallen to about 0·045 per cent., and they are removed immediately by the addition of glucose to the blood either by administering this sugar subcutaneously or by causing it to be liberated in the body from glycogen, as by the injection of adrenalin (epinephrin). It was found, moreover, that, of all the sugars, glucose alone has an immediate and lasting effect, even leavulose and galactose, which are its nearest neighbours, having only a slight and transitory action.

Although the symptoms commonly occur in well-fed

[1] A lecture delivered in the Section of Physiology of the British Association at Liverpool on September 17.

animals when the blood sugar is about 0·045 per cent., they may fail to be observed until a much lower level has been reached. This is particularly the case when a large dose of insulin is given some time after food. The liability of symptoms to occur at the above percentage of blood sugar has served as a useful basis for measurement of the dosage of insulin, one unit being defined as the amount which can lower the blood sugar to the convulsive level of 0·045 per cent. within four hours in rabbits weighing about 2 kilogrammes. Since this "physiological" unit, as it is called, is said to be stronger than is necessary for certain clinical purposes, it has been decided for the present to use, as the "clinical" unit, one that is one-third the above strength. This question of the physiological assay of insulin is receiving much attention at present.

These observations clearly pointed the way to the next problem, namely, the cause for the lowering of blood sugar. At first it seemed as if this should soon be solved, for, as already mentioned, it has been found that insulin not only causes glycogen to be deposited in the liver of diabetic animals, when sugar is given, but also causes the respiratory quotient to become raised in a manner to indicate that there is increased combustion of carbohydrate. It seemed likely that stimulation of the same processes in the normal animal under insulin must be responsible for the disappearance of glucose from the blood. But the experimental evidence goes to show that the mechanism of action is much more complex. It has recently been found that glycogen is not formed when insulin is given along with sugar to normal animals (McCormick, O'Brien, and E. C. Noble); indeed, when given to those that are well fed it is decreased in amount (Dudley and Marriam), and no certain evidence can be obtained from respiratory experiments that more active combustion of glucose is a necessary accompaniment of the lowering of blood sugar. The consumption of oxygen greatly increases in dogs preceding the onset of symptoms, and the respiratory quotient usually becomes somewhat raised (Dixon, Eadie, and Pember), but in mice changes of an opposite character occur (Dudley, Laidlaw, Trevan, and Boock); in rabbits the symptoms are at first like those in dogs, though less marked, and subsequently like those in mice.

The glucose which disappears is apparently neither oxidised to carbon dioxide and water nor polymerised into glycogen. For the present the problem is unsolved, but we must not lose sight of the possibility that insulin changes both glucose and glycogen into some intermediary product which we fail to identify with our present methods of analysis, either because it does not give the reducing reactions upon which the detection and estimation of sugars depend, or because it is not precipitated by alcohol after treatment with strong alkali, which is the characteristic property of glycogen. That such substances may exist in the tissues is indicated by the fact that it is impossible after injecting large amounts of sugar into animals to recover much more than one-half by chemical analysis of the entire body.

Whatever may be the nature of the mechanism by which the blood sugar becomes lowered, there is no doubt that it acts in the tissues and not in the blood itself (Eadie). Thus, the addition of insulin to blood incubated outside the body does not alter the rate at which the sugar disappears from it, and when the isolated heart is perfused with a suitable saline solution containing sugar the addition of insulin to the solution causes this to lose its sugar more rapidly (Hepburn and Latchford). The hypoglycæmic effect of insulin lasts for a period which varies in different animals. In rabbits the blood sugar often begins to rise again in about an hour after the injection, but this depends very largely on the amount of glycogen which is stored in the liver. This becomes converted into glucose to replace that lost from the blood, so that well-fed animals show much quicker recovery and can withstand much larger doses of insulin, without the development of symptoms, than those previously starved. This mobilisation of the carbohydrate reserves would appear to depend on the transmission to the liver through its nerve supply of messages set up by the hypoglycæmic condition, for Burn has shown that if the nerve pathway (splanchnic) be locked by the drug ergotonine, insulin causes, in well-fed animals, a more profound degree of hypoglycæmia than otherwise.

Another important effect of insulin is on the hyperglycæmia due to other causes than removal of the pancreas. So far as it has been investigated, insulin is capable of preventing the development of hyperglycæmia in all these conditions. Most attention has been paid to its effect on the hyperglycæmia due to epinephrin, partly because of the possibility that insulin may be assayed by determining the amount necessary to antidote a known amount of epinephrin, which itself can be accurately assayed, and partly because an investigation of the physiological antagonism between these two hormones may throw some light on the mechanism of the action of insulin. One example may be given to illustrate this. We have seen that insulin causes the glycogen stored in the liver to become less in amount, acting in this regard like epinephrin, although probably much less quickly. When insulin is given along with epinephrin, however, glycogen disappears from the liver much more slowly than with epinephrin alone, indicating that under certain conditions the pancreatic hormone arrests rather than stimulates the breakdown of glycogen. When these two hormones are in excess in the body, one prevents the other from causing glycogen to disappear. Another curious result of a somewhat similar nature has been obtained by Burn with pituitrin, a hormone derived from the pituitary gland. When it is given along with epinephrin it also prevents hyperglycæmia, and when it is given with insulin it prevents hypoglycæmia. These results indicate the very puzzling nature of the problem of the action of insulin, and they show that this action may possibly be linked with that of other hormones in the animal.

Chemically, insulin usually gives the biuret test, and it behaves in its general properties not unlike a proteose. It may, however, be a much simpler substance, since active preparations have been obtained from the pancreas of the skate, in which no biuret test could be obtained. Its chemical identity being unknown, it is of course out of the question that it could at present be prepared synthetically.

The Origin of Petroleum.

UNLIKE most problems concerning origins, which have but a philosophic or academic interest, that of the genesis of petroleum has a distinctly practical significance, for if solved, prospectors for mineral oil would be provided with important data and chemists might learn how to produce artificially valuable substances similar to, if not identical with, natural petroleum. Man's fertile imagination has spun not only an embarrassing number of speculations and hypotheses concerning the nature of the raw material or materials from which petroleum has been derived, but also innumerable explanations of the *modus operandi* of its formation. Of these, only a tithe remains. Explanations that affirm a cosmic origin or postulate volcanic activity as the effective cause, have long been abandoned, and to-day there are only three which find scientific support. The least popular of these, the inorganic theory, affirms that petroleum originates from the interaction of metallic carbides, presumed to exist immediately below the earth's outer crust, and steam, whereby various hydrocarbons are formed, and these undergo further changes, including polymerisation, to produce the compounds that are found in petroleum. It has recently been suggested that the methane synthesis from carbon monoxide or dioxide and hydrogen, in the presence of a catalyst, such as vanadium or nickel, of which traces are found in petroleum, might also explain the initial formation of hydrocarbons in Nature, and the presence of methane in natural gas; but these suggestions fail to interpret the occurrence of optically-active substances in petroleum, and the presence of nitrogen in some oils, while geologists have met them with uncompromising hostility.

The views that are uppermost to-day are that petroleum is derived from either animal or vegetable substances, or from both of these sources, and the chief direct evidence supporting this organic theory is the occurrence in petroliferous strata of vegetable and animal remains, including, in a few cases, remains of bacteria. Important, if less direct, testimony is the presence in petroleum of the optically-active substances cholesterol and phytosterol, which are characteristic constituents of animals and plants, respectively. The various elaborations of this view are mainly concerned with the nature of the chemical reactions involved, and how they are influenced by the three determining factors of pressure, temperature, and time; it is, however, not easy to formulate any one hypothesis to explain the formation of such complex mixtures as mineral oils, and still more difficult to account for the great diversity in chemical composition exhibited by mineral oils from different localities.

The evidence admitted by those who believe in a purely animal origin includes the statements: that petroleum found in primary rocks is much more often accompanied by animal than by vegetable remains; that formations containing only plants are not bituminous; that mixtures of hydrocarbons similar to those found in petroleums can be made artificially from animal fats, and that such production can be observed in Nature to-day, notably in the coral reefs and lagoons of Djebel Zeit in Egypt. The scarcity of animal fossils in petroliferous strata is explained by assuming that the fauna were either skeletonless, or, if not, their calcareous coatings were dissolved by the carbon dioxide liberated during their decomposition. Advocates of the vegetable origin doubt if the supply of animal matter has been sufficient for the purpose, plants being much more plentiful than animals; they comment on the absence of phosphatic deposits from the vicinity of oilfields; and many trace relationships between coals and petroleum.

Mr. E. H. Cunningham-Craig is one of the foremost supporters of the purely vegetable theory, and in opening the discussion on the origin of petroleum, held by the Institution of Petroleum Technologists in London on October 9, he brought forward evidence in its favour derived from recent researches. Geological evidence is accumulating in support of the view that coals and lignites are related to petroleum. Thus, in Trinidad, the three main oil-bearing horizons have each a carbonaceous phase in some other district, and the petroliferous and carbonaceous phases approach each other very closely in some localities. Similar evidence is found in Venezuela, Burma, Assam, Hungary, and Rumania. The D'Arcy well, near Dalkeith, was drilled on the assumption that oil-shale deposits represent petroleum that is "dead and buried," and therefore that free petroleum might be found beneath the oil-shale series; actually it was discovered below the oil-shale at each of two predicted depths. Dr. F. Bergius, of Heidelberg, has hydrogenised coal by heating it in free hydrogen in an autoclave at very high pressures and at temperatures up to 455° C. As the result of an exothermic reaction, a liquid was obtained that was "almost identical with crude petroleum." The determining factors of the formation were the proportion of volatile matter in the coal and the pressure. Nature, it is thought, may act in a similar way, but more slowly and at lower temperatures, on vegetable matter before it has reached the coal stage, *i.e.* while it still contains much hydrogen in proportion to carbon.

Supporters of the animal theory, said Mr. Cunningham-Craig, should endeavour to repeat Dr. Bergius's experiments with animal matter in place of vegetable. Cannel coals yield most oil on distillation; they contain much inorganic matter and are not highly carbonised. Torbanites also give high yields of oil and are to be regarded as cannels containing colloidal inorganic matter which has been heated in a natural autoclave. In this process it is assumed that the oil liberated from the torbanite combines with the colloidal inorganic matter to form the gels that can be seen in the microscope; but the conversion into petroleum has not been complete owing to partial carbonisation. Prof. A. E. Flynn has separated and investigated the gels occurring in torbanite from Nova Scotia, and has proved conclusively that they are not vegetable fossils; so that if oil-shale is petroleum "dead or buried," torbanite is petroleum "still-born."

Mr. Cunningham-Craig's paper met with many criticisms, both from the chemists, led by Dr. A. E. Dunstan, and from the geologists, led by Mr. Dewhurst. Dr. Dunstan raised obstacles to more than one theory; for example, he cannot admit that the laboratory methods of producing hydrocarbons from fatty acids

are applicable in Nature, and it is difficult to see why the molecules of such acids occurring in natural fats and containing even numbers of carbon atoms should give rise to molecules present in petroleum which contain both odd and even numbers of carbon atoms. He has analysed many times the liquids obtained from coal by the Bergius method, and has found that their similarity to petroleum is very remote. How can the presence of benzene, toluene, and xylene in certain petroleums be explained? Is it not probable that there are several modes of origin? Light is required on the origin of the vast amounts of methane present in natural gas. What happens to the nitrogen and phosphorus contained in animal organisms? Why is iodine so scarce in petroleum? Mr. Dewhurst said that petroleum found in the Upper Silurian was much earlier than the earliest vegetation, and earlier than the coal found in the Late Devonian. Palæozoic oil was probably formed from any organic matter available, and there were two distinct types of oilfield: the lignitic, of vegetable origin, which was deposited in areas where the climate was moist, and oilfields of marine animal origin, which are found associated with deposits of salt, gypsum, etc., and were formed in deltas that were cut off later from the mainland.

The discussion generally was suggestive and served its purpose in crystallising thought around important nuclei. If it did not bring nearer a definitive solution of the problem, it at least showed how far we have progressed since the time when a Polish cleric, named Kluk, traced the origin of petroleum to the Garden of Eden, which was so fertile that it must have contained fats; at the Fall this fat partly volatilised and partly sank into the earth, where it was finally transformed into mineral oil by the changes induced by the Flood. Truly, a science progresses by changing its points of view.

Obituary.

Dr. Herbert McLeod, F.R.S.

Dr. HERBERT McLEOD, who died on October 3, was born at Stoke Newington on February 9, 1841, and was the son of Mr. Bentley McLeod. He was educated at Stockwell Grammar School. In 1860 he became lecture assistant to Prof. A. W. Hofmann at the Royal College of Chemistry. Former students of this College never forget the brilliant way in which McLeod carried out the experiments shown at the lectures. Hofmann was so impressed by his ability that he arranged that, in addition to acting as his assistant, McLeod should take the entire College curriculum. He worked with Hofmann on aniline dyes and had a part in the discovery of magenta. McLeod accompanied Hofmann to Berlin. A little later he returned to the Royal College of Chemistry as assistant to Prof. Frankland. At this period he published papers on acetylene, on a new form of aspirator, and, in conjunction with Frankland, a Report to the British Association on the determination of the gases in well-waters.

In 1871 McLeod was appointed professor of experimental science (afterwards chemistry) at the Royal Indian Engineering College, Cooper's Hill. He held this post till 1901. In 1876 he published a description of "An Apparatus for Measurement of Low Pressures of Gases." The McLeod gauge described in this paper is now commonly used. A little later, in 1878, McLeod published, in conjunction with G. S. Clarke (now Lord Sydenham), a paper on "Some Figures exhibiting the Motion of Vibrating Bodies and on a new Method for Determining the Speed of Machines." The method, developed in this and in later papers on the subject, has since led to most important applications. He devised a sunshine recorder and took a keen interest in meteorology, making daily observations at 9 A.M. and 3 P.M. over a period of twenty years.

A visit paid by the late Lord Salisbury to the Royal College of Science led him to invite McLeod to co-operate with him in scientific experiments. Week-end visits to Hatfield House were frequent until Lord Salisbury became Prime Minister. Some account of these experiments was given in the obituary notice of Lord Salisbury which McLeod wrote for the Royal Society.

From 1888 onwards McLeod had been reading proofs of the Royal Society's Catalogue of Scientific Papers. After the death of Mr. George Griffith in May 1902, McLeod undertook the direction of this Catalogue. His chief work upon the Catalogue was the preparation of a subject-index to all scientific papers published between 1800 and 1900. All the index slips necessary for this work were prepared under his direction, and the volumes for mathematics, mechanics, and physics were published. The author Catalogue for 1883–1900 was also under his charge, and he had seen half of this through the press when, in 1915, he was obliged, through ill-health, to give up active work.

McLeod was honorary LL.D. of St. Andrews, was elected a fellow of the Royal Society in 1881, and was president of the Chemical Section of the British Association at Edinburgh in 1892. He became a fellow of the Chemical Society in 1868 and served on its council in 1871–74, and again 1880–84. He was vice-president of the Chemical Society in 1887–90, and again 1901–4. He served on the Council of the Royal Society in 1887–89.

Dr. Arthur A. Rambaut, F.R.S.

Arthur Alcock Rambaut, Radcliffe Observer at Oxford, who died at a nursing home on October 14, after a prolonged illness, was born at Waterford on September 21, 1859, and was a son of the Rev. E. F. Rambaut. At Trinity College, Dublin, he won a first science scholarship in 1880 and took his degree the following year as senior moderator and gold medallist in mathematics and mathematical physics. Having spent some time as senior science master at the Royal School, Armagh (where he had been educated himself), he was in 1882 appointed assistant at the Dublin University Observatory at Dunsink under Sir Robert Ball. He had charge of the transit circle and observed regularly with it for about eight years, the results being published in Parts VI. and VII. of the "Astronomical Observations and Researches made at Dunsink." This work was laid aside when Mr. Isaac Roberts presented the observatory with a 15-inch reflector, with which some of his earliest work in astronomical photography had been made. Rambaut

commenced work with this instrument as soon as the clockwork had been somewhat improved, and a photographic survey was made of the great star cluster in Perseus and published in a paper by Ball and Rambaut in the Trans. R. Irish Academy. Soon after, in the autumn of 1892, Ball left for Cambridge and Rambaut was appointed to succeed him as Andrews professor of astronomy and Royal Astronomer of Ireland. During the next five years he continued his photographic work, but under great difficulties and with long interruptions, as the mounting, clockwork, and the dome under which the instrument was housed were all found to be useless and had to be replaced by others.

In 1897 Rambaut left Dunsink to take up the post of Radcliffe Observer at Oxford. Up to that time the Radcliffe Observatory had been devoted almost altogether to meridian work, and the observations made since 1839 had been regularly published. But a vast number of observations made in the years 1774 to 1838 had never been prepared for publication, and Rambaut spent a good deal of time examining them. He showed that they had been carefully made and would be worth printing, but he did not succeed in obtaining the necessary means for reducing and printing these old observations. In the meantime the Radcliffe Trustees decided to procure a first-class instrument for astronomical photography, and a tower was built in the grounds of the observatory, surmounted by a dome 32 feet in diameter. In this was, in 1902, erected a photographic instrument by Sir Howard Grubb, consisting of a photographic refractor of 24 inches aperture and an 18-inch refractor for visual work. In 1904 stellar parallax work was commenced, arranged according to the programme proposed by Kapteyn and in consultation with him, and this work has been continued ever since. A volume of the Radcliffe Observations published about a month ago contains the resulting parallaxes of 2400 stars in addition to full descriptions of the instrument and measuring apparatus.

More than a year ago Rambaut was attacked by illness, from which he never recovered. It was therefore very fortunate that the chief work of his life had been completed. He will be much missed by the many friends his cheerful and kindly disposition had won for him at Oxford. He leaves a widow and three sons to mourn his loss. J. L. E. D.

Dr. J. A. Harker, O.B.E., F.R.S.

John Allen Harker was born at Alston, Cumberland, on January 23, 1870, and died at Highgate on October 10. He was thus only in his fifty-fourth year at the time of his death. The son of the Rev. John Harker, Congregational minister, he was educated at Stockport Grammar School, thence proceeding to the University of Manchester (Owens College), where he was elected Dalton scholar in chemistry in 1891 and a year later Berkeley fellow in physics, taking his M.Sc. A research course at Tübingen followed, where he took the Ph.D.

Harker spent some little time in France, working with Moissan on electric furnaces, and in collaboration with Chappuis carried out in 1900 a classic comparison of the gas and platinum thermometer scales. About this time the National Physical Laboratory was being brought into being at its first home at Kew Observatory, and Dr. Harker was one of the little band of devoted workers whom Sir Richard Glazebrook gathered round him at the beginning of the great endeavour which resulted in the present institution at Teddington. Harker became chief of the thermometry branch of the Physics Department. His work over a period of the next ten years is largely reflected in a series of valuable papers, mostly on high temperature measurement, for which he received the F.R.S. in 1910. At the International Petroleum Congress at Vienna in 1912 he was the delegate of the British Government. His researches with W. F. Higgins on flash-points of oils enabled him to make valuable contributions to the discussions. In association with the present writer, Dr. Harker subsequently worked on the thermionics of high-temperature furnaces—a subject on which he gave a Friday evening discourse at the Royal Institution. In 1913 he went for several months to Eskdalemuir Observatory as temporary superintendent.

When the War broke out Harker was lent by the National Physical Laboratory to the Inventions Department of the Ministry of Munitions, and became director of the research laboratory and was responsible for the organisation of the work of the Nitrogen Products Committee. In this capacity he visited Canada and the United States in 1918, and was on board the Cunard liner *Andania* when she was torpedoed off northern Ireland. On that occasion a generous act of self-sacrifice undoubtedly aggravated the ill effects of the exposure on his constitution. Harker also went on similar missions to Norway, Sweden, and France. He received the O.B.E. in recognition of his valuable War services.

After the War, Harker returned to Teddington for a brief period before setting up as a consulting engineer with Dr. J. F. Crowley in Westminster. He was a vice-president of the Faraday Society, and had served on the Council of the Physical Society. He was a prominent member of, among others, the Oxygen Committee and the Gas Cylinders Committee of the Research Department.

Harker was a man of great scientific keenness and a highly strung and very likeable personality, who will be greatly missed by his friends. He possessed a great fund of scientific reminiscences. Though never of robust physique, he did not hesitate to make frequent inroads on his reserve of nervous energy. His devotion to his War duties doubtless served to undermine his constitution, and at the end his illness was only short in duration. He married Ada, the daughter of the late Thomas Richardson, of Alston, and had two sons and three daughters. The cremation took place at Golders Green on Saturday, October 13. Among those present were Sir Richard Glazebrook and Sir Robert Robertson. Dr. T. E. Stanton represented the Royal Society and Dr. E. Griffiths and Mr. F. H. Schofield the Director and staff of the National Physical Laboratory. G. W. C. Kaye.

We regret to announce the following deaths:

Rev. H. J. Bidder, a curator of the Botanic Garden, Oxford, on October 19, aged seventy-six.

Mr. R. A. P. Rogers, Donegal lecturer in Trinity College, Dublin, on October 17.

Current Topics and Events.

SPAHLINGER'S consumption cure is once more brought to public notice, and, at the invitation of Baron Henri de Rothschild, Mr. Spahlinger met a number of medical men at the Ritz Hotel in London last week. In an article in NATURE, April 7, p. 453, we published the main facts, so far as they were known, of Spahlinger's consumption cure. His claims were shown to rest on a series of categoric statements of which we still await scientific proof. In some mysterious way, however, the subject recurs like the seasons, and yet we get no further. We are now informed that he cannot produce the "goods" because the Spahlinger family fortune to the extent of 80,000*l*. has been spent in the experiments, and therefore more will be required before the public can taste the benefit. When it is remembered that such a sum would nearly maintain the Rockefeller Institute in New York for a year, it is difficult to understand why the result is so meagre. The object of the meeting in London was to produce a pamphlet which would give the history of Spahlinger's work, particulars of papers which have been read, and clinical histories of the cases hitherto treated. When these works have been in the hands of doctors for a month or six weeks, we are going to hear about the Spahlinger treatment again, we are told, for an appeal will be made to a generous public for money to carry on the work. In these days of scarcity, it would seem advisable to know something about the remedy apart from the claims made on its behalf.

THE statement made by Sir L. Worthington-Evans to the Imperial Economic Conference, on cable communication throughout the Empire, is quite satisfactory. Before the War none of the Atlantic Cables was owned by a British company. Now there are two. The German cable from Emden to New York *via* the Azores has been acquired and diverted, and the cable of the Direct United States Co. has been purchased. The average transmission time for full-rate telegrams between London and Montreal is now about 45 minutes. The other link in the State-owned route to Australia and New Zealand is the Pacific Cable laid in 1902. It is now loaded to its full capacity, and the question of duplicating it is under consideration. In other parts of the world the cables provided by the Eastern Telegraph Co. and its associated companies have proved capable of meeting the demand. These companies and the Pacific Cable Board did invaluable work during the War. Britain, however, has fallen behind other nations in radio communication. America, France, Germany, Japan, and the Argentine have outstripped us. This is due to the apparently interminable negotiations between the Marconi Company and the Government. We have good hopes that with the able help of the Dominion Premiers an agreement will soon be arranged. Lord Burnham suggests that permission be given to private enterprise to operate the stations, the Government reserving the right of purchase after a term of years. Judging, however, from the analogous experiment that was tried when electricity supply companies were first established in Great Britain, we think it very doubtful whether a scheme of this nature would succeed. Several other suggestions have been made, and we sincerely hope in the national interests that this little-creditable dispute will soon be settled.

SINCE Summer Time was first introduced in 1916, many different views have been expressed as to when it should begin and end. Expediency rather than principle seems to have determined these dates, which, in Great Britain, have varied from March 24 to April 8 at the beginning and September 17 to October 25 at the end. There has also been no general agreement between Great Britain and other European countries as to the period during which Summer Time should be in force. Mr. Bridgeman, Home Secretary, told a deputation from the Newcastle Chamber of Commerce on October 19 that he was consulting authorities in France in the hope of arriving at such an agreement. The dates in Great Britain, namely, the day following the third Saturday in April and the day following the third Saturday in September, are laid down by the Summer Time Act, and it will be necessary to repeal or amend this Act in order to extend the period, as urged by the Newcastle deputation. Duration of daylight is, of course, a function of latitude, so that whatever dates are decided upon for the change of time-reckoning must be a compromise as to their effects, even in different parts of Great Britain. During the summer months Newcastle and places north of it do not need Summer Time legislation to give them daylight during all their working hours. On this account, it has been suggested that Greenwich Time should be used near the summer solstice—say in June and July—so that clocks would have to be altered four times a year instead of two. This would, however, increase the confusion already caused by the introduction of Summer Time, and we trust that the change will be limited to two dates a year, whatever they are.

IT is rather interesting to note that among the representatives of the Dominion of Canada at the Imperial Conference now sitting in London, five of them are fellows of the Royal Society of Canada. The Rt. Honourable William Lyon Mackenzie King, Prime Minister, author of several works on political economy; Dr. O. D. Skelton, professor of political economy at Queen's University; Dr. R. H. Coats, Dominion Statistician; Col. A. G. Doughty, Dominion Archivist, are all members of Section II. (History and Literature) of the Royal Society of Canada, whilst Dr. Charles Camsell, who is honorary secretary of the Society, Deputy Minister of Mines, and has under his direction the Geological Survey, the National Museum, and the Mines Branch of the department, is a member of Section IV. (Geological and kindred Sciences). There is also associated with these representatives Dr. J. H. Grisdale, Deputy Minister of Agriculture, also the head of the Experimental Farms of the Dominion, the post formerly

held by a past president of the Royal Society of Canada in the person of the late Dr. W. E. Saunders. It is thus evident that in the fields of literary, historical and scientific research in Canada, the right men were found to represent that portion of the British Empire at the Imperial Conference.

On Tuesday next, October 30, occurs the centenary of the death of Dr. Edmund Cartwright, the inventor of the power loom and other textile machinery. Born in 1743, a few years after Arkwright, his life coincided with the great Industrial Revolution, to which he made notable contributions. Of a good Nottinghamshire family, he was educated at Wakefield Grammar School and at University College, Oxford, and took holy orders. He was given the perpetual curacy of Brampton, near Wakefield, and in 1779 he was appointed to the living of Goadby Marwood, in Leicestershire; it was there he made his first loom. It was during a holiday visit to Derbyshire in 1784 that his attention was directed to the need of a mechanically worked loom, and though he had had no previous experience of mechanics or weaving, with the aid of the village carpenter and smith, he made a rude form of loom which could be worked by other agency than the hands and feet of the weaver. He took out patents, at Doncaster set up a factory, and there produced the earliest samples of power woven goods. At the same time, he turned his mind to the difficult problem of wool-combing by machinery, and here again made a certain amount of advance. His projects, however, proved financial failures, and in 1793 he sold his factory and removed to London. Among his other inventions was an engine to be driven by steam or spirit vapour, in which he applied the practice of surface condensation. He was also known for his experiments in agriculture and for several years worked for the Dukes of Bedford at Woburn. Though the power loom came into use somewhat slowly, by the beginning of the nineteenth century it was becoming common, and in 1809 Cartwright's services to the cotton industry were acknowledged by the grant to him by the Government of a sum of 10,000*l*. A part of this Cartwright spent on the purchase of a farm in Kent, and there he spent the evening of his days, experimenting to the last.

"The Martyr Roll of Science" is the title of a sympathetic article by Mr. Harry Cooper in the *Sunday at Home* for October, in which details are given of the life and work of many of those who have given their lives in the pursuit of knowledge and the service of mankind. No mention is made of the victims of engineering and chemical and physical research, and only a passing reference to those of geographical exploration—Franklin, Scott, and Shackleton—the bulk of the article dealing with the tragic happenings of medical research. Arthur Bacot and H. T. Ricketts were stricken down by typhus fever, and the interesting information is given that a hundred years ago Sir Humphry Davy likewise contracted typhus fever, then so familiar in prisons as to be known as "gaol fever," having visited Newgate in order to devise a disinfectant against the disease, but happily recovered. Yellow fever claimed Jesse Lazear, who allowed himself to be bitten by mosquitoes that had fed on the blood of yellow fever patients. The list of X-ray martyrs is unhappily a long one—Hall-Edwards, Lyster, Clarence Dally, Ironside Bruce, Radiguet, Kassabian, Vaillant, Bergonié, and others. Kala-azar attacked Pirrie, and other names might have been added to Mr. Cooper's roll of honour. Thus trypanosomiasis claimed Tulloch; African tick fever, Dutton; yellow fever, Walter Myers; and typhoid fever, Louis Jenner and Allan Macfadyen. "Such heroisms give the answer to those who imagine Science to be a rigid, emotionless thing, and its devotees to be hard men, forgetful of humanity in their intellectual absorption."

The inaugural lecture of Prof. A. V. Hill in the Anatomy Theatre of the Institute of Medical Sciences at University College on October 16 was a brilliant and inspiring account of the present tendencies of physiological science. Prof. Hill came to physiology from physical science and is thus more favourably situated in regard to his freedom of suggestion and criticism than many biologists of a more restricted training. As present tendencies, he instanced the unparalleled advance in biochemistry during the past few years. It is now difficult to define precisely where physiology ends and biochemistry begins. Day by day the analysis of the whole mechanism of the living organism becomes more refined and elaborate. Prof. Hill cited the brilliant work of Hartridge and Roughton, which has recently brought the study of the time-course of the reactions of hæmoglobin with gases, occupying only a few hundredths of a second, under direct experimental observation. The development of further and finer physical methods of analysis is another tendency, while the old main road of the experimental method remains an essential means to progress in physiology. Direct physiological research on man is developing to the great advantage of medicine and sociology. It is essentially the study of the normal. A fifth tendency is less obvious: the amplification of the field of zoology through the adoption of experimental methods. That may help to correct the analytical tendency. Re-synthesis is necessary and zoology will not forget the animal as a whole. Anatomy, too, will gain as increasingly greater emphasis is placed upon the living structure, and the elucidation of the working of the central nervous system will link up structure with function. Not the least interesting remarks of Prof. Hill were those concerning the spirit of adventure—even a reckless spirit of adventure—in science, without which the most highly organised team work must be sterile and bureaucratic. The adventurer may be wrong, but he "catalyses" his more reasonable brothers.

The Salters' Institute of Industrial Chemistry has awarded sixty-four grants in aid to chemical assistants, occupied in factory or other laboratories in or near London, to facilitate their further studies.

Through the generosity of the late Mrs. E. O Durham, wife of Lieut.-Col. F. R. Durham, chairman of the Junior Institution of Engineers, 1907–1909, that Institution has offered annually a bursary of 25*l*. for competition among its members between the ages of 20 and 23 years. By her will, the Institution is to receive a sum to endow the bursary in perpetuity.

We learn from *Science* that at the annual meeting of the American Chemical Society at Milwaukee on September 12, the Priestley medal, awarded triennially by the society for distinguished services to chemistry, was bestowed on Dr. Ira Remsen, president and emeritus professor of Johns Hopkins University, Baltimore.

The Council of the Institution of Civil Engineers has made the following awards in respect of selected engineering papers published without discussion during the session 1922–1923: A Watt medal to Mr. T. E. Houghton (Liverpool); and Telford premiums to Mr. J. W. Meares (Guildford), Mr. J. W. Spiller (Maidenhead), and Dr. G. S. Coleman (Manchester) and Mr. Dempster Smith (Manchester); and in respect of papers read before meetings of students of the Institution in London and the provinces during the same period,—Miller prizes to Mr. E. L. Everatt (Newcastle), Mr. J. G. Kimber (London), Mr. A. H. Naylor (London), Mr. E. Sykes (Birmingham), and Mr. F. J. Symonds (London).

Applications are invited for the post of an assistant government analyst in Ceylon. Candidates must have had experience in general analytical and bacteriological work and in toxicological analysis, be associates or fellows of the Institute of Chemistry by examination in branch E (chemistry—including microscopy—of food, drugs, and water), and preferably possess an honours degree of a British University. Application forms and further particulars are obtainable from the Assistant Private Secretary (Appointments), Colonial Office, S.W.1.

A movement is on foot to commemorate the late Sir Isaac Bayley Balfour. An area of 50 acres in Glenbranter Forest, Argyllshire, where the plants raised at the Botanic Garden, Edinburgh, can be cultivated under suitable conditions and where trials may be made in the rearing of newly imported conifers and other trees, has been secured for the purpose. It is proposed that the area shall be called the Bayley Balfour Arboretum or Garden, and that the memorial shall take the form of a rest-house for the use of visitors. Subscriptions towards the memorial are solicited. They should be sent to the honorary secretary and treasurer, Mr. J. Sutherland, 25 Drumsheugh Gardens, Edinburgh.

Messrs. Longmans and Co. are publishing shortly vol. 1. of a work on "Cosmology," by Prof. J. O'Neill, of Maynooth, which, it is said, is the first attempt at an English treatise on scholastic cosmology. The study of the text of Aristotle and of St. Thomas has led the author to ascribe to these thinkers views different from those attributed to them in most contemporary manuals. The second volume on "Modern Cosmology" will be published next year; its purpose is to show that scholastic cosmology contains a sounder philosophy of matter than any of its present-day rivals.

Our Astronomical Column.

Comets.—Very careful search for D'Arrest's Comet has been made by photography by Dr. Innes at Johannesburg and Dr. Baade at Bergedorf, Hamburg; several other astronomers have spent much time in visual searching but without success. The comet has not been seen for two revolutions; the perturbations up to 1917 were computed by Mr. Braae, and those for the present revolution by Mr. Cripps, starting with Braae's elements for 1917. As there was a fairly close approach to Jupiter at the last aphelion passage, it is possible that the second-order perturbations, which were not computed, were sufficient to have a considerable effect on the comet's position. If this is not the case, we must conclude that the comet has suffered disintegration, like those of Biela and Brorsen.

Baade's Comet of October 1922 was still under observation in August by Dr. van Biesbroeck at Yerkes Observatory, its magnitude being about 14.

Dr. Strömgren welcomes the observation of comets over long arcs, since it enables the eccentricity of their orbits to be determined. This is of importance in discussing theories of their origin.

The Einstein Shift in the Solar Spectrum.—Two articles on this subject have lately appeared, which both reach an affirmative conclusion on the presence of the shift in the solar spectral lines that Einstein predicted. *Science* for September 28 contains a summary of a paper read by Prof. C. E. St. John to the American Association for the Advancement of Science. It will be remembered that his earlier conclusions tended to the negative side, but this summary makes it clear that he has now reached an opposite conclusion. Details are not given, but the following quotations clearly express his main result. "The lines of the solar spectrum are not identical in position with those due to incandescent samples of the same elements when observed on the earth, and the displacement is toward the red end of the spectrum." "The displacements of the lines . . . predicted by Einstein amount to 86 per cent. of the total observed effect, the remainder being due to other well-known effects."

The other paper is by Dr. J. Evershed in the October issue of the *Observatory*, and gives details of the confirmatory verdict which was announced to the R.A.S. last June. The lines of iron, titanium, calcium, nickel, sodium, cyanogen, were studied in the sun and in the arc; the study covered all parts of the solar disc, the back of the sun being accessible by means of the light reflected by Venus near superior conjunction. The pressure effect is concluded to be negative, the photosphere having a much lower pressure than our atmosphere. He states that "there seems to be very little doubt that the Einstein effect is present in the solar spectrum; the observed shifts . . . seem impossible to explain by motion, pressure, or anomalous dispersion." It remains to find an explanation of the excess of shift shown by the high level lines in the ultra-violet, and the differences given by separate lines.

Research Items.

Disease Godlings in Eastern Bengal.—*Man in India*, a periodical edited by that active anthropologist, Rai Bahadur Sarat Chandra Roy, has steadily improved in value as it has now reached its third volume. Perhaps the most interesting article in an excellent number is that on "The Cult of the Godlings of Disease in Eastern Bengal," by Mr. Sarat Chandra Mitra. He gives further evidence to show that the cults of the higher gods—Brahma, Vishnu, and Siva—retain little influence on the rural populations, which is devoted to the propitiation and control of a mob of malignant demons, who cause disease among men and animals, failure of crops, and other evils which menace the villages.

Tattooing and Lip Distortion.—Two valuable ethnographical articles, both illustrated by drawings and photographs, appear in *L'Anthropologie* (vol. xxxii. Nos. 1-3, August 1923). The first, by Dr. J. Herber, entitled "Les Tatouages du pied au Maroc," describes a remarkable series of foot tattooing in Morocco, the markings taking in some instances an imitation of jewellery, such as anklets, and other decorations of the calf. The second paper, by M. Gaston Muraz and Maddh, Sophie Getsowa, entitled, "Les Lèures des Femmes Djingés, dites Femmes-a-Plateaux," describes the extraordinary types of the labrets used by the Saras-Djingé, improperly called the Saras-Kabas, a tribe of fetish-worshippers in the neighbourhood of Lake Tchad, between the right bank of the Chari and the Arab district of Salamat. The French officers now in charge of this region have taken active measures to prevent this barbaric form of decoration of the female face.

Fatigue Research in Factories.—The Journal of the Royal Statistical Society (July, 1923) contains a paper by Dr. D. R. Wilson on "Some Recent Contributions to the Study of Fatigue." The writer, after giving a short historical outline of the activities of the Industrial Fatigue Research Board, gathers together the conclusions, usually expressed in a tentative way, furnished by several different investigations in different industries. He points out that conclusions, even though they are perforce based on a study of a few individual cases, when confirmed in several widely differing industries, are probably sound. Industrial research as yet is in its infancy, and conditions for carrying it on in a factory bear no resemblance to those of a laboratory. A particular factory may employ only a few individuals on a given process, but, owing to the constitution of the factory, these individuals are typical of any likely to be employed for that process. It therefore seems a likely hypothesis that what is true of these particular individuals with regard to such general problems as the length of the working day, rest pauses, ventilation, etc., will be true of others. It is pointed out that factory research is of the nature of applied science and that the conclusions and methods of several sciences not only have to be utilised, but also adapted, for the particular conditions of factory life.

Mendelian Inheritance in a Fern.—The variations of the hart's-tongue fern, *Scolopendrium vulgare*, are well known and have often been illustrated by Druery and others. Prof. W. H. Lang (*Journ. Genetics*, vol. 13, No. 2) has studied the offspring produced by sowing the spores of a plant which was apparently normal except that one leaf was incised on one side though normal on the other. The prothalli so produced gave rise to young plants 75 per cent. of which were normal (entire leaved) and 25 per cent. incised. The latter, when reproduced by spores, bred true like extracted recessives, while the two entire-leaved offspring both proved to be again heterozygous. The original plant was evidently heterozygous, the normal condition being completely dominant to incised leaf. When spores were sown singly, thus producing isolated prothalli, such prothalli gave rise either to all entire-leaved or to all incised-leaved plants, showing that, in accordance with theory, the segregation of factors had taken place in the spore formation.

Revision of the Catillocrinidæ.—The family of Devonian and Carboniferous crinoids known as Catillocrinidæ is peculiar in combining marked asymmetry in the composition of the cup with but slight asymmetry in its shape; while a large anal tube does not prevent a tendency to symmetry in the fringe of unbranched arms, 11 to 58 in number, which spring directly from the edge of the cup. Mr. Frank Springer's study of this assemblage (Smithson. Misc. Coll., lxxvi. No. 3, Aug. 1923) not only adds new facts to our knowledge of it as well as of the Symbathocrinidæ, but also raises questions of far-reaching importance. These families as well as their allies and admitted ancestors have always been credited with a monocyclic base; in other words no infrabasals have been detected or even supposed to exist in the cup. Mr. Springer now describes and illustrates by photography three small plates hidden within the basals of *Catillocrinus tennesseeae*, the oldest species of the genus. He does not consider that such plates occur in any later members of the family, a fact which may be explained as due to atrophy; but neither does he claim that they may have existed in the predecessors of Catillocrinus. He does, none the less, conclude that these plates are true infrabasals and that "in this species there is a dicyclic base." We hesitate to accept so revolutionary a decision on the evidence of three specimens of one highly modified species. On the other hand, we welcome the support of this distinguished worker for the suggestion that the faunas from Timor which Wanner refers to the Permian are in part of Lower Carboniferous age.

Control of Bunt and Smut.—In Bull. C. No. 3 of the Welsh Plant Breeding Station, K. Sampson describes how satisfactory control of bunt of wheat and covered smut of barley can be obtained by the use of dry copper carbonate, as well as by solutions of copper sulphate and formalin. The dry treatment proved to be good from all points of view save that of cost, but an equally efficacious and less expensive dressing is found in anhydrous copper sulphate and calcium carbonate.

The Gorge of the Arun.—Capt. C. J. Morris on his way back from the last Mount Everest expedition visited the little-known gorge of the Arun in Nepal. He contributes a paper on the subject to the *Geographical Journal* for September. It was known that below the village of Teng the river falls some 4000 feet in 20 miles, and the object of the expedition was to examine this stretch of the river. This drop was found to be due to a steady fall in the bed of the river, which passes through narrow defiles in which the cliffs rise in places to 10,000 feet above the water level. Capt. Morris's paper contains a sketch map of the gorge of the Arun.

Scale for Sea Disturbance and Swell.—On the North Atlantic meteorological chart for October a new scale for sea and swell disturbance is tentatively

suggested. Criticisms or alternative suggestions are invited. The scale, which is proposed by Capt. H. P. Douglas, late Assistant Hydrographer, uses the old notation of 0 to 8 for the sea, and adds 9 for a confused sea caused by currents, tide, a sudden swift of wind, but not necessarily by strong wind. Swell is also shown on a scale of 0 to 9, the main types of swell being designated short, long, low, and high. By a combination of the sea and swell scales, the state of disturbance of the surface waters is expressed by two figures. Thus 43 means a rough sea with a high swell: 37 means a moderate sea with a long heavy swell. The adoption of this or some comparable code and scale would result in greater precision in records than is now possible.

Rainfall in Australia.—Rainfall charts of Australia prepared by the Commonwealth Meteorologist from the records of 1280 well-distributed stations show that in the year 1922 there was an excess above the average rainfall in 21 per cent. of the total area of the continent. In 1923 this figure was 63. During 1922 the totals were the lowest on record in several places between the south-west corner of Queensland and the plains of New South Wales. Throughout the interior from the Lake Eyre basin to the inland parts of Queensland, New South Wales, and Victoria, and also in the north-west of Western Australia, the shortage was considerable, and would have been more pronounced were it not for the heavy falls in December. The areas with rainfall above the average were chiefly in the tropical north, and in the centre and south-east of South Australia. The wheat areas in New South Wales and Victoria experienced a marked shortage, but the falls were so opportune that in most parts a good harvest was secured. It was the pastoral areas of Australia which suffered most severely. The chart gives annual and monthly rainfall maps and a series of insets showing distribution of rainfall above the average in every year since 1908.

Cold Air-waves in the United States.—Prof. R. de C. Ward of Harvard University deals with this subject in the *Scientific Monthly* for May. The author makes reference to cold waves alluded to by past pioneers of weather changes, such as Redfield and Prof. Joseph Henry, who realised the progress of cold periods across the continent, from the Rocky Mountains to Bermuda, prior to the publication of weather maps for the United States. The cold waves were then recognised as associated with the rear segments of cyclonic circulations moving to the eastward. The official definition of a cold wave is a fall of temperature amounting to a certain number of degrees in 24 hours, with a minimum below a fixed standard. Minimum temperatures are not so far below the normal in the north as in the south, and where crops are growing all the year round, frosts are dangerous at any time. For intensity cold waves are practically unique in America, and following as they do warm winds associated with the advance segment of a storm, the sudden drop of temperature is very great, amounting to between 20° F. and 40° F. in the 24 hours. The rapidity of advance is determined by the travelling speed of the cyclonic and anticyclonic areas with which the wave is associated. Three or four severe cold waves are generally experienced each winter in the United States, and they commonly last for two or three days. Various activities and interests are seriously affected during the spell of cold. On the Pacific coast cold waves are few and not severe, and in California the occasional frosts are the product of radiation on clear anticyclonic nights. Northers and blizzards are well described.

Atomic Disintegration.—A paper on the photography of atomic disintegration, by Harkins and Ryan, appears in the Journal of the American Chemical Society for September. Photographs of the disintegration of the atom are given, the retrograde motion of the colliding α-particles being plainly visible. A new type of rays is described, called by the authors ζ-rays; they give very faint but definite tracks. Their range is very many times greater than that of δ-rays, and they are probably due to electrons torn out of the atom, possibly from the K level. In the course of the experiments described, it is remarked that oblique impacts never effect nuclear disintegration.

Sulphur as a Fungicide.—Mr. Harry Curtis Young has recently published (Annals of Missouri Botanical Garden, 9, pp. 403-435, 1922) a valuable contribution to the much-investigated problem as to the reason for the toxicity of sulphur when used as a fungicide for the control of disease upon plants. He finds that sulphur owes its toxic properties to pentathionic acid, an oxidation compound formed from sulphur and water. On this account the sulphur needs to be applied in a very finely divided and therefore easily oxidised form, and he recommends colloidal sulphur liberated in a medium containing buffers so that it is easily maintained at a reaction between P_H 4·0-5·5; above or below this hydrion concentration pentathionic acid is not stable. In the light of this general conclusion there is a brief discussion of the practical problem of producing a suitable sulphur spray or vapour, but the author's investigations on this side of the problem are still in progress.

Petroleum and Natural Gas in America.—The advance chapters on Petroleum (ii. 31) and Natural Gas (ii. 32) of the Mineral Resources of the United States for 1921 appeared recently, and they furnish some interesting data concerning the post-War phase of the oil-industry in that country. Following unsettled conditions for some six months after the armistice, a gradual revival took place culminating in the oil-boom of 1920, but giving place later to a period of intense depression characterised by a serious drop in the price of oil and its various products, the chief economic feature of 1921. In the spring of 1922 a definite improvement was manifest, which has progressed steadily until the present time, when, in fact, the industry is suffering from a vastly different but equally serious malady from that of 1921—overproduction—and for this California is largely to blame. In 1921 there were produced in the United States 472,183,000 barrels of oil and 724,052,000 M cubic feet of natural gas; while the former figure represents a 33 per cent. increase since the end of the War, the latter shows a significant decrease compared with the two previous years, and it is generally conceded that the natural gas industry in America has reached and is gradually passing its peak of production, so that a steady decline may be anticipated for the future. With petroleum the situation is different, and it is difficult to foresee the trend of events, though once California ceases to produce in the present amazing fashion, the decline-curve for the whole country will undoubtedly be apparent. It is interesting to note that the average daily production of oil in the United States at the moment is about 2,400,000 barrels, to which California contributes practically one-third; in 1921, the year under review, the average daily production for the country was approximately 1,300,000 barrels, to which California contributed less than 25 per cent.

Second Triennial Pan-Pacific Science Congress.

MELBOURNE AND SYDNEY, 1923.

THE Science Congress in Australia in August has been, on the whole, highly successful. Between eighty and ninety visitors from overseas joined with a large number of local members in carrying through a fairly extensive programme of work. It is scarcely to be expected that congresses of the kind will receive many, or any, highly important original contributions to science; their value and their opportunity lie rather in bringing together the workers in widely separated countries, enabling them freely to discuss common problems and ideas, but above all to plan broad systematic investigations on the most efficient co-operative bases possible. The principal achievements of this Congress have certainly been in the last-mentioned direction. In nearly every one of the sciences with which it dealt (including agriculture, anthropology, botany, entomology, forestry, geodesy and geophysics, geography and oceanography, geology, hygiene, veterinary science and zoology), there is abundant room for international effort and team work in so vast an area as that within and bordering upon the Pacific Ocean. The recognition of this has been the driving force behind the whole Congress. Many practical proposals have been brought forward, the carrying out of which will do much for the progress of scientific inquiry in this region.

The general organisation, in the hands of the Australian National Research Council, has been much on the lines of a British Association meeting. The scope and value of the whole movement will no doubt rapidly increase. It is already understood that the 1926 gathering will be in Japan (Tokyo and Kyoto), and that the Japanese Government most generously proposes to make available a sum equivalent to 23,000*l*. to cover expenses.

The Sydney session is not yet concluded at the time of writing, but it is possible to give some indication of the main work of the first session, held in Melbourne on August 13-22.

To many, the most important business of the Congress was that faced by the Anthropology and Ethnology Section, which set itself the task of devising a practical scheme for the immediate intensive study of the native races in the Pacific. So far at least as British possessions are concerned, some very definite proposals have been drawn up, in the consideration of which Dr. Haddon, Sir Baldwin Spencer, Mr. W. J. Perry, and, by letter, Sir James Frazer, Prof. G. Elliot Smith, Prof. C. G. Seligman, and Dr. B. Malinowski, have taken part. These have already been received favourably by the Commonwealth Minister for Home and Territories. They provide not only for field workers but also for the establishment of a school in one of the Australian universities for training both scientific workers and Government administrative officers. There is reason to hope for most valuable results in the few years that yet remain before the rapidly disappearing native cultures pass beyond recall. On Sir Baldwin Spencer's initiative, definite schemes for work on the mainland among the remaining wild tribes have also received the support of the whole Congress.

In the Section devoted to Agriculture, it was to be expected that irrigation and land settlement, especially from the economic point of view, would occupy chief attention. Californian and Australian workers, especially, exchanged striking accounts of development work. That the latter could point to an increase in agricultural and pastoral revenue in the Commonwealth from 80,000,000*l*. in 1906 to 260,000,000*l*. in 1921 showed, even after allowing for higher prices and a slightly increased population, how much was being done by agricultural research and education. The chief decision of the section was an insistence upon the paramount importance of soil surveys, showing characters of both soil and subsoil, and, when practicable, the native flora growing on each type of soil. A resolution to this effect will be presented to the Government of every country in the Pacific region.

Botany, Forestry, Entomology, and Zoology Sections conducted many of their meetings in common. Dr. van Leeuwin (Dutch East Indies) gave an account of the progressive changes which have taken place in the vegetation of Krakatoa since the devastation of 1883. The first (wind-borne) arrivals were spore-producing plants. With time the number of new cryptogams decreased. Seeds of flowering plants came, carried either by wind or birds. Casuarinas arrived early and formed forests. These are now being suppressed by later arrivals, which are tropical rain forest plants; the vegetation being at the present time somewhat similar to that existing prior to the volcanic outbreak and exceedingly dense. The study of this vegetation has been a remarkable example of international co-operation, Dutch, British, French, American, Swiss, and German scientific workers all sharing in it.

The much closer connexion in flora between Australia and the Philippines than between the former and the nearer islands to the north-west was due, according to Dr. E. D. Merrill (Manila), to a former land connexion through New Guinea. This land connexion he termed Eastern Malaysia, maintaining that it was separated from Western Malaysia by an area in "unstable equilibrium," bounded on the east by Weber's line and on the west by a modified Wallace's line. This unstable area had to a large extent prevented movements of plants east and west.

The forestry work was chiefly of local interest. Every scientific gathering in Australia points out the supreme folly of the vast destruction of forests which has taken and is still taking place as settlement advances; and this Congress was no exception to the rule.

The entomologists dealt chiefly with problems presented by indigenous and imported insect pests, particularly the various species of termites in Australia and the timber-boring insects of the islands to the north. The dangers threatening Australia were very fully emphasised and will be the subject of communications to Governments.

A discussion on the genetics of domesticated animals initiated by Profs. E. B. Babcock (California), Cossar Ewart (Edinburgh), and W. E. Agar (Melbourne), resulted in a decision by the Zoology Section to form a special committee of five geneticists to collect information on all genetic research now in progress in Pacific countries and to report to the next Congress. The protection of native fauna was strongly emphasised here, too, every country insisting on the international importance of preserving from destruction much of the unique fauna of Australia. A public meeting was held during the Congress to give support to local authorities in contemplated action towards this end.

With Sir Gerald Lenox-Conyngham and Dr. E. F. J. Love in charge of the Section of Physics, it was natural that geodesy should be very much to the fore. The slight contributions made so far by Australia to this science were contrasted with the

great significance of the study from economic and national defence points of view, and with the chance which Australia has, from its geographic position, form, and dimensions, of making a highly important contribution to knowledge of the figure of the earth and of the form of the lithosphere.

The wide work on terrestrial magnetism being carried out chiefly by the United States was discussed at some length, and again Australia was urged to take up her fair share of it. The desirability of continuing and extending the work of the non-magnetic ship *Carnegie* was affirmed. Other highly interesting subjects cannot be more than mentioned by name, such as gravity work in Japan and the Philippines; earth tides and their employment for determining earth rigidity; pulsatory vibrations and the causes of destruction by earthquakes, with an account of safeguards to property adopted in Japan; international solar physics research; determination of gravity at sea; comparison of accuracy of wired and wireless longitude determinations.

Three matters stand out in the work of the Geography and Oceanography Section. The first is the presence in Sydney Harbour of the new U.S.A. scout cruiser *Milwaukee* (10,000 tons; 35 knots), specially sent out by the American Government to demonstrate to the Congress the Sonic Depth Finder. The vessel has journeyed some ten thousand miles and has obtained a chart of the Pacific bed over which it passed. While the instrument is not yet fully perfected, its value not merely for rapidly obtaining accurate knowledge of the sea bottom, but also in increasing the safety of vessels in many of the intricate channels among the Pacific islands, very greatly impressed the Congress, while the object-lesson of a fighting vessel devoted to scientific work was a valuable one. The second was a full exchange between the countries represented of information as to what they are doing (or, in the case of Australia, merely beginning to do) in the matter of hydrographical surveys. A very fine exhibition of maps was made, principally from the Royal Topographical Service of the Dutch East Indies. Prominence was given to the need for work in the neighbourhood of the Great Barrier Reef and elsewhere. In some regions, charts drawn by Matthew Flinders are still perforce being used. The third subject of importance was the pressing need for co-ordination of meteorological work in the Pacific. There are now numerous stations, working independently, overlapping, and apparently incapable of co-ordination among themselves. The solution urged was the appointment of a British officer at Samoa, it being believed that in no other way could the difficulties in the way of the needed association of activities be established.

Geology possessed numerically the largest Section of all, and a huge amount of matter, nearly all descriptive, was put before it. Indeed, a "pool" of geological information was created, every country contributing as much to it as time, very strictly allotted, would permit. It is impossible to set out briefly the nature of the work discussed; the main subjects have already been indicated in a former article. Between section meetings the geologists distributed themselves over the countryside.

The Hygiene Section went fully into problems connected with mining industries, under the leadership of Drs. R. R. Sayers (U.S.A.), Watkins Pitchford (South Africa), and J. H. L. Cumpston (Australia). Methods of ventilation, sanitation, and medical examination were discussed from different points of view. The progress of the hookworm campaign was followed. In Queensland, where 12 per cent. of the miners are affected, the value of this work is being fully demonstrated.

The establishment of an international organisation, with a number of mobile units moving from island to island introducing methods of modern preventive medical science, is deemed essential if the present dwindling of population of native races in many island groups is to be arrested. New Caledonia in 1853 had 70,000 natives; in 1900 the number was 19,000. Measles from Sydney killed 26 per cent. of Fiji's population in 1875, while influenza in 1918 took off 20 per cent. of the natives of Samoa. There is also continuous heavy toll taken by tuberculosis and venereal disease. A basis for part of the discussion was provided by results, obtained from a widely circulated *questionnaire*, showing the distribution of such diseases as plague, smallpox, leprosy, malaria, beri-beri, and others.

In view of the importance of animal life in the economic positions of most of the Pacific countries, a joint discussion between the Hygiene and Veterinary Science Sections on the difficult subject of international animal quarantine regulation had more than passing interest. The fact that "surra" in the Philippines makes it impossible for horses to be kept shows the significance of the whole matter to Australia. Definite proposals have not yet been submitted to the full Congress.

It will be seen that throughout, the main functions assumed by the Congress have been to examine carefully existing lines of work, and then to point to outstanding needs for individual and combined effort in tackling the innumerable scientific problems of the Pacific region. The extent to which such stimulus will lead to action during the next three years will be the test of the value of a meeting of the kind.

A. C. D. R.

Diseases of Fruit in Storage.

ATTENTION was recently directed in Nature (vol. 111, April 14, p. 516) to the direct efforts now being made in the United States to open up a new field of service for plant pathology, through the study of the best conditions for preserving fruit and vegetable produce in the market and in transit.

It would seem that in Great Britain, in a less direct manner, through the activities of the Food Investigation Board, working under the auspices of the Department of Scientific and Industrial Research, the same field of service is gradually opening to the scientific investigator. Thus the work of Mr. F. T. Brooks and his collaborators upon the fungus organisms contaminating chilled meat, recently noticed in Nature (vol. 111, April 28, p. 582), was carried out for this Board, which has now issued, as Special Report No. 12, a report upon "brown heart"—a functional disease of apples and pears, by Dr. Franklin Kidd and Dr. Cyril West.

Occasionally when apples and pears are in storage, or when in transit by ship to Great Britain, although entirely healthy to outward appearance, the inner portion of the fruit decays and turns brown; no organism is found to be present as the cause of this diseased condition, which may be widespread.

The authors report that, in 1922, this internal decay, which they have described as "brown heart," was so prevalent among apples imported from Australasia as to arouse anxiety among those connected with the fruit trade. In a report which is singularly direct in

its analysis of the cause of the practical problem and in indicating the direction in which prevention of the disease may be looked for, the authors show clearly how laboratory investigations, at first sight remote from the practical problem, contribute to its solution.

Laboratory experiments have shown that an exactly similar "brown heart" condition may be produced in home-grown apples, under carefully controlled conditions which leave no doubt that the internal decay takes place when the concentration of carbon dioxide in the internal atmosphere, in the air spaces ventilating the tissues of the apples, exceeds a certain toxic limit. The ventilating system and its communication with the external atmosphere, varies with the variety of apple; naturally, therefore, the toxic limit is reached with different rapidity in different varieties, and thus a reasonable explanation is found of the different varietal susceptibility to "brown heart."

The authors establish experimentally that within wide limits the oxygen concentration is not responsible for "brown heart," and their examination of the ships' holds where "brown heart" has appeared during the voyage confirms the view that it is to be associated with a high percentage of carbon dioxide in the hold where the apples were stored. Thus the importer, the grower, or salesman concerned with the storage of apples and pears has his attention directed to one clearly defined pathological condition to which the fruit is subject, and at the same time a clear suggestion as to the direction in which a remedy may be found.

Incidentally the authors think that their work also elucidates an old-standing problem of the grower, whose apples frequently suffer from a functional disorder known as "bitter-pit." Brown discoloured patches appear just under the skin of the apple and dry up leaving the pits. The original browning and decay seems to be exactly similar to the internal decayed tissue in "brown heart," and is probably traceable to the same cause, a local excess of carbon dioxide in the tissue just below the skin which then turns brown. This suggestion will greatly interest apple growers. "Bitter pit" much depreciates the value of a good apple, and attention will certainly be turned to the possible causes of such local excessive accumulations of carbon dioxide in the ventilating system of the apple tissue.

The New Mechanics.[1]

It is interesting to speculate on the forecasts which would have been made at the beginning of the century as to the condition of physical theory now. The state of knowledge at that time would have suggested that the atomic theory would proceed to develop along the lines of the older mechanics. One or two phenomena already known did not seem to fit in very well, but it was not very unreasonable to suppose that the increase of knowledge would remove these difficulties. The physicist of that time would not have conjectured what has actually come to pass. There are at present two great bodies of doctrine, either of which seems to hold over a wide field, but neither of which can be at all reconciled with the other. Nature is more like both than like any compromise between them. Of these two doctrines, one is the old-fashioned mechanics, which works for many atomic phenomena; the other—the new mechanics—is known as the *quantum theory*. The underlying true mechanics are really quite unknown, but we have a curious set of rules which have an extraordinary knack of giving the right answer; the branch of mathematics with which these rules are most closely connected is, rather unexpectedly (and with a good deal of qualification), elementary arithmetic. It is the purpose of the lecture to illustrate this.

The first illustration is "atomic number." It has been found possible to number off all the elements known to chemistry, starting from hydrogen 1, helium 2, and so on up to uranium 92, and these numbers have a simple physical meaning which is the most important thing that can be said about the elements. The atomic number is simply the total number of *electrons* which revolve round the *nucleus* of the atom. It can be studied in a variety of ways, of which the most striking is the α-ray photographs of C. T. R. Wilson.

More complicated illustrations are given by the Bohr theory of spectra. The best approach to the subject is through the phenomenon of resonance potentials. If an electron strikes an atom with more than a certain amount of energy, the collision is inelastic and the energy is radiated away all in one wave-length. The collision has raised the atom from one definite condition to another, and the return causes the emission. A complete theory of the hydrogen spectrum has been founded on this idea, and as a result of this theory the various conditions of the atom can be described by labelling the electron (there is only one in hydrogen) with two numbers—thus 4_2 or 6_1. In the higher elements the same idea works and each electron has certain numbers associated with it; here, however, the number pairs have not quite the precisely defined dynamical meanings that can be given them in hydrogen. The spectral lines can also be described in terms of numbers. These numbers have not yet been made to yield the absolute values of the wave-lengths, but it is possible by their means to unravel the general characters of what are often highly complicated systems of lines. For a line, two groups of numbers are required, such as $5(3,2) \rightarrow 2(2,2)$, and there are rules as to what pairs of numbers may go together—for example, the second members of the two groups can differ only by 1, the third by either 1 or 0, whereas the first may differ by any amount. There is still a great deal of work to be done on the subject, but it seems probable that all spectra will at no very distant date be brought under rules of this kind.

This is a very incomplete sketch of the successes of the quantum theory, but that theory is only a partial view of the whole of Nature, because it leaves out of account certain indirect ways in which spectral lines exhibit themselves. The chief of these are the ordinary processes of reflection and refraction of light, which are very well explained on the older theory. A reconciliation of the two views seems at present quite impossible, and this can only mean that there are fallacies in some of the fundamental assumptions that we make unconsciously. Of these almost the only ones, that it would do any good to abandon, are the belief in the continuous nature of time and space, beliefs which have been disturbed by the Relativity Theory of Einstein, which will probably have to be once again revolutionised to reconcile atomic theories. To any one who finds difficulty in Einstein's theory, and that is to every one, this is a rather depressing prospect, but it is quite possible that the new revolution, whatever it may be, will tidy up the whole field and make it easier to deal with, even though it will superficially be less like than before to our crude ideas of the nature of the world.

[1] Synopsis of an address delivered on October 16 at the University of Edinburgh by Prof. C. G. Darwin, the first occupant of the Tait chair of natural philosophy in the University.

University and Educational Intelligence.

Cambridge.—Mr. F. J. W. Roughton and Mr. W. R. Dean have been elected to fellowships at Trinity College.

A letter from the Chairman of the University of Cambridge Commissioners has been received inviting representations from University bodies and from individual members or groups of members of the Senate on matters in which they desire the proposals of the recent Royal Commission to be modified. These should be sent before the end of the year to the Secretary to the Commissioners, Mr. H. A. Hollond, Trinity College.

Edinburgh.—Prof. J. J. R. MacLeod, professor of physiology in the University of Toronto, who was awarded the Cameron prize for 1923, delivered two lectures in the University on October 16 and 17 respectively, on the nature of control of the metabolism of carbohydrates in the animal body. He dealt with the discovery of insulin and its value in the investigation, not only of diabetes, but also of other problems of metabolism. The Cameron prize was founded in 1878, and is awarded to an investigator who in the course of the five years immediately preceding has made an important addition to practical therapeutics.

Prof. T. J. Mackie, formerly professor of bacteriology in the University of Cape Town, who was recently appointed Robert Irvine professor of bacteriology, devoted his inaugural address to a survey of the present position of medical bacteriology. Prof. Mackie has made arrangements for developing the teaching of bacteriology as a subject for the degree of B.Sc.

Dr. J. E. M'Cartney has resumed duty as lecturer in bacteriology after a year's leave of absence granted to enable him to carry out researches on certain filterable viruses in the Rockefeller Institute.

Leeds.—The West Riding County Council has decided to devote the proceeds of a penny rate to the assistance of university education, which has already in the past been consistently supported by the Council.

Mr. W. F. Shanks has been appointed professor of physiology. Dr. Shanks graduated B.Sc. at the University of Glasgow in 1913, with special distinction in physiology, and M.B., Ch.B., in 1915 with commendation. In 1920 he was appointed lecturer in physiology at Glasgow and acted as senior assistant to the Regius professor of physiology. For the last three years he has also been in sole charge of a special course in physiology for the new degree of Bachelor of Education (Glasgow), in which the subject is treated from a special point of view with regard to the physiology of the child, psychology, and other cognate aspects.

The following further appointments have been made: Mr. F. J. Brown to be assistant lecturer in zoology; Mr. A. W. Anderson and Mr. J. McGregor, district lecturers in agriculture; Mr. G. Milne, temporary assistant lecturer in agricultural chemistry; Mr. H. Preston, assistant science tutor; Miss M. K. Morgan, assistant lecturer in geography; and Miss E. Newcomb, assistant lecturer in education.

London.—Free public lectures on "The Treatment of Injuries of the Long Bones produced by Accident or Disease" will be delivered by Prof. E. W. Hey Groves at Guy's Hospital Medical School at 5.30 on November 8, 9, 12, and 13.

Societies and Academies.

London.

Optical Society, October 11.—E. T. **Hanson**: Notes on the elementary algebraic theory of a class of photographic objectives. Equations expressing the absence of Seidel's first four aberrations in an objective consisting of two thin systems of lenses, separated by an interval, are formed. When each of the two thin systems consists of only two lenses, the equations can be put in a form which admits of an elegant graphical solution, regard being paid to the necessity of obtaining a solution in which no one of the lens curvatures exceeds a certain limit.—T. **Smith**: A general survey of the thin double lens. The shapes of the lenses and the types of glass suitable for the construction of an objective free from all first-order aberrations in a primary plane for an infinitely distant object are found on the assumption that the system is composed of two separated thin lenses, each of which consists of glasses cemented together. The analysis indicates that "old" achromats should be used for both component lenses, a conclusion not in accordance with modern practice.—T. F. **Connolly**: New types of levelling instruments using reversible bubbles. A true level can be obtained using reversible bubbles, as the mean of two observations from a single station. The theory is then applied to the design of various types of "self-adjusting" levels and to the adjustment of a collimator.

Paris.

Academy of Sciences, October 1.—M. Albin Haller in the chair.—A. **Lacroix**: The composition of the meteorite which fell at Saint-Sauveur (Haute-Garonne) in 1914. The examination by metallographic methods proved the presence of metal (nickeliferous iron) and enstatite, with smaller proportions of clino-enstatite, oldhamite, maskelynite, apatite, and graphite. A complete chemical analysis is given, the portion removable by acids (mainly metallic) being examined separately.—Emile **Picard**: H. G. Zeuthen.—Vito **Volterra**: The movement of a fluid in contact with another fluid and surfaces of discontinuity.—Maurice **Gevrey**: The formation and use of Green's functions in the integration of linear partial differential equations of any order whatever with imaginary characteristics.—F. H. **van den Dungen**: New technical applications of integral equations.—Antoine **Zygmund**: On trigonometrical series.—R. **Jacques**: Two networks the two tangents of which belong to linear complexes and the transformations of the equations of the surfaces of constant total curvature.—Serge **Bernstein**: The principle of stationarity and generalisations of Mendel's law.—P. **Stroobant** and P. **Bourgeois**: Certain stars the movements of which are parallel and equal to that of the sun.—Paul **Pascal**: The slow formation of a definite compound in mixed crystals. Some anomalies in the cooling curves of mixtures of benzylidene-aniline and anisylidene-aniline have been shown to be due to the slow formation of a definite compound of one molecule of the latter compound with two of the former.—René **Dubrisay** and Pierre **Picard**: The capillary phenomena manifested at the surface of separation of water and vaseline oil in the presence of fatty acids and of alkalies. The drop volume method has been applied to the study of the changes in the surface tension at the surface of separation of vaseline oil and aqueous solutions. The latter included solutions of caustic soda and sodium carbonate, of sodium carbonate and sodium bicarbonate, and of caustic soda with common salt.—H. **Gault**: The soluble ester salts of starch and

the higher fatty acids. Ordinary starch, suspended in a mixture of pyridine and toluene, heated with lauryl chloride, gives a dilaurate of starch. Details of its properties and analysis are given.—Adrien **Guébhard**: The Japanese earthquake.—E. **Rothé**: Earthquakes in France in 1920–21. A table giving locality, time, degree, and epicentral region of nine earthquakes in 1920 and six in 1921. The greatest seismic activity was in the region of the Pyrenees.—E. G. **Mariolopoulos**: The formation of local Mediterranean depressions and the Norwegian theory of the "polar front." The local Mediterranean depressions appear to be formed in accordance with the Norwegian theory of the "polar front."—A. **Guilliermond** and G. **Mangenot**: Cytological observations on the mode of formation of essential oils. The method adopted is based on the selective staining power of indophenol blue. The sections are made by hand or in the freezing microtome, stained, and observed in water. The results of the observations do not confirm the view that there is a relation between tannoids and essential oils.—M. **Prianichnikov**: The assimilation of ammonia by the higher plants. The experiments cited lead to the conclusion that the plant, whether green or etiolated, absorbs ammonia energetically from ammonium salts. Nitrates must be reduced to ammonia before absorption by the root. If in agriculture, the development of the plant is roughly proportional to the rate of nitrification, the causes are of a secondary nature; anything which prevents nitrification, such as acid reaction or insufficient aeration, also prevents the development of the higher plants, so that the nitrification is an important criterion of the condition of the soil.—V. **Lubimenko**: The specific action of light rays of various colours in photosynthesis.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 9, No. 9, September).—J. **Stieglitz**: (1) A theory of colour production. By reduction, every dye becomes colourless, forming the "leuco-dye"; by oxidation of the latter, the colour is restored. Indophenol owes its colour to the combination within the molecule of a strong positive oxidising atom with a strong negative reducing atom. Colour intensity is increased by increasing the reducing side with a base. The reducing electrons are freed sufficiently from *intra*-atomic restraints to permit vibrations which absorb a portion of white light, the complementary colours appearing in the dye. A similar argument is used to explain the colour of basic dyes such as pararosaniline. (2) A theory of colour production: inorganic compounds. Colour may be produced by a loosely held electron in an atom with an odd number of valence electrons (G. N. Lewis), by *intra*-atomic or *inter*-atomic oxidation reduction potentials, or by both the latter, in the manner similar to that described above in (1).—G. **Strömberg**: The asymmetry in the distribution of stellar velocities (see NATURE, October 20, p. 600).—W. J. **Luyten**: On the mean absolute magnitudes of the K and M giants and the systematic errors in trigonometric parallaxes. The mean absolute magnitude of the Ko giants, assumed to be independent of their position in space, is about $+0\cdot7$ mag.; that of the M giants is about $-0\cdot2$ mag. No large systematic error is found in the Allegheny trigonometric parallaxes.—C. E. **Seashore**: Measurements on the expression of emotion in music. Musical expression can be conveyed entirely by the sound wave: frequency determines pitch, amplitude intensity, duration of the single wave extensity, and the form of the wave timbre. All these factors can now be recorded and analysed; *e.g.*, the vibrato in singing is a synchronous pitch and intensity pulsation of about 6 oscillations a second.—G. A. **Miller**: Groups of order 2^m in which the number of the sub-group of at least one order is of the form $1+4k$.—L. **Thompson**: The motion of a falling chronograph projectile. With this instrument, neither the projectile being timed nor the projectile of the chronograph which carries the photographic surface for taking the record, strikes a material object during the experiment. Corrections are made for the influence on the early motion of the chronograph projectile of the magnet from which it is released and also for air resistance. The instrument measures with an error not greater than 1/2,000,000th sec.

CAPE TOWN.

Royal Society of South Africa, August 15.—Dr. A. Ogg, president, in the chair.—M. **Rindl**: Preliminary note on the active principles of the yellow tulip (*Homeria pallida*). The alcohol extract, after removal of the solvent, was separated into a water soluble portion and into a resin. The former yielded crude alkaloid equivalent to 0·017 per cent. calculated on the weight of the plant material. Only 23 per cent. of this is water soluble, and the stems and leaves seem to owe their toxic properties mainly, if not entirely, to this water soluble alkaloid. The alkaloid exerts a digitalis-like action on the circulation, and in large doses is a cardiac poison. Its action is not cumulative. The aqueous solution appears to contain two other alkaloids differing in their behaviour towards organic solvents, as well as an organic base. A primary amine and a very small amount of a glucoside were detected. Extracts from the corms and sheaths contain active substances of the nature of a cardiac tonic. They are very poisonous, and administered to animals in successive small doses, they send the heart into fibrillation and cause sudden death.

SYDNEY.

Royal Society of New South Wales, September 5.—Mr. R. H. Cambage, president, in the chair.—E. H. **Booth**: Atmospheric dust and atmospheric ionisation. A persistent nucleus—which is presumed to be the Langevin large "ion"—requires for condensation a supersaturation 1·075, corresponding to a diameter of $1\cdot25\times10^{-6}$ cm., taking the density as unity. This is not found in filtered air, nor does it grow in filtered air. It may be produced in filtered air if the air is bubbled through water, although the condensation can be in no way dependent on electrification effects. A "foreign" nucleus is essential; electrification merely enables it to be recognised by mobility tests.—A. R. **Penfold** and R. **Grant**: The germicidal values of Australian essential oils (exclusive of Eucalypts) and their pure constituents, together with those for some essential oil isolates and synthetics. Pt. 1. When tested against *B. typhosus*, the pure constituents, as well as a number of isolates and synthetics, were found to possess coefficients varying from 6 to 20, ketones, alcohols, and a number of phenols possessing well-marked germicidal properties; 1 per cent. suspensions of the bodies examined were prepared in 7½ per cent. rosin soap solution for examination. The phenol ethers, safrol, and isosafrol were found to possess coefficients of 11 to 12. Thymol manufactured in Sydney from piperitone gave the same coefficient as the natural isolate, 25.—A. R. **Penfold** and F. R. **Morrison**: Preliminary note on the electrolytic reduction of piperitone. The preparation in quantitative yield of isomenthone from piperitone by electrolytic reduction at 20-30° C., using a nickel cathode. A current density of 3·5 to 4 amp. was employed with an E.M.F. of 6-10 volts,

the reaction being completed in 12-13 hours using 100 c.c. of ketone. Highly lævo-rotatory samples of piperitone yielded menthone of high dextro-rotation, the semicarbazone of which melted at 113° C.

Official Publications Received.

Commercial Intelligence Department, India. Agricultural Statistics of India, 1920-21. Vol. 2: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, and Land Revenue Assessment in certain Indian States. Pp. v+205. (Calcutta: Government Printing Office.) 1.8 rupees.

Reprint and Circular Series of the National Research Council. No. 46: Problems in the Field of Animal Nutrition. By Sub-Committee on Animal Nutrition. Pp. 9. (Washington: National Academy of Sciences.) 15 cents.

Bergens Museums Aarbok, 1921-1922. 1 Heft. Pp. 28+26+41+23+5+50. (Bergen: A/S John Griegs Boktrykkeri og N. Nilssen & Søn.)

Department of Agriculture, Tanganyika Territory. Report for the Year 1922. Pp. 30. (Dar-es-Salaam.)

Arbeten utgifna med Understöd af Vilhelm Ekmans Universitetetsfond, Uppsala. 29: Die Goten und Langobarden in Italien. Von Nils Åberg. Pp. viii+166. (Uppsala: Almquist & Wiksells Boktryckeri A.-B; Haag: M. Nijhoff; Leipzig: O. Harrassowitz; Paris: Honoré Champion.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1321: Fumigation of Citrus Trees for Control of Insect Pests. By R. S. Woglum. Pp. 59. (Washington: Government Printing Office.) 10 cents.

South Australia: Department of Mines. Geological Survey of South Australia, Bulletin No. 10: The Building Stones of South Australia. By R. Lockhart Jack. Pp. 73. (Adelaide: R. E. E. Rogers.)

Straits Settlements. Annual Report on the Raffles Museum and Library for the Year 1922. By Major J. C. Moulton. Pp. 18. (Singapore.)

Department of Agriculture, Trinidad and Tobago. Administration Report of the Director of Agriculture for the Year ended December 31, 1922. Pp. 14. (Trinidad.) 6*d*.

Commonwealth of Australia. Institute of Science and Industry: Professional Papers. Presidential Address to the Australasian Association for the Advancement of Science, at the New Zealand Meeting, January 1923, by Sir George H. Knibbs: Science and its Service to Man. Pp. 46. (Wellington: W. A. G. Skinner.)

Annual Report of the Meteorological Committee to the Air Council, for the Year ended 31st March 1923. (M.O. 258.) Pp. 62. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

The Phylogenetic Method in Taxonomy: the North American Species of Artemisia, Chrysothamnus, and Atriplex. By Harvey M. Hall and Frederic E. Clements. (Publication No. 326.) Pp. vi+355+58 plates. (Washington: Carnegie Institution.) 6.75 dollars.

The Third-Chromosome Group of Mutant Characters of *Drosophila melanogaster*. By C. B. Bridges and T. H. Morgan. (Publication No. 327.) Pp. x+251+3 plates. (Washington: Carnegie Institution.) 3 dollars.

Undernutrition in Steers: its Relation to Metabolism, Digestion and Subsequent Realimentation. By Francis G. Benedict and Ernest G. Ritzman. (Publication No. 324.) Pp. viii+333+2 plates. (Washington: Carnegie Institution.) 3.25 dollars.

Interferometer Experiments in Acoustics and Gravitation. By Prof. Carl Barus. Part 2. (Publication No. 310.) Pp. viii+113. (Washington: Carnegie Institution.) 1.75 dollars.

Genetic Studies on *Drosophila virilis*; with Considerations on the Genetics of other Species of Drosophila. By Charles W. Metz, Mildred S. Moses and Eleanor D. Mason. (Publication No. 328.) Pp. 94+5 plates. (Washington: Carnegie Institution.) 1.75 dollars.

Diabetic Metabolism with High and Low Diets. By Elliott P. Joslin. (Publication No. 323.) Pp. ix+334. (Washington: Carnegie Institution.) 4.50 dollars.

Astronomical and Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the Year 1919; under the Direction of Sir Frank Dyson. Pp. 8+Axx+A52+C3+D123+5+Exx+E82+19. (London: H.M. Stationery Office.) 40*s*. net.

Cape Astrographic Zones. Vol. 6: Catalogue of Rectangular Co-ordinates and Diameters of Star Images derived from Photographs taken at the Royal Observatory, Cape of Good Hope; commenced under the Direction of Sir David Gill, completed and prepared for Press under the Supervision of S. S. Hough. Zone −46°. Pp. xxxvii+506. (London: H.M. Stationery Office.) 100*s*. net.

Zone Catalogue of 20,843 Stars included between 40° and 52° of South Declination referred to the Equinox 1900, derived from Meridian Observations and Photographs made at the Royal Observatory, Cape of Good Hope; under the Directions of Sir David Gill and S. S. Hough. Pp. lxxi+418. (London: H.M. Stationery Office.) 100*s*. net.

The University of Leeds. Calendar, 1923-24. Pp. 556+xxxvi. (Leeds.)

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1922. Pp. 119. (Bristol.)

Smithsonian Miscellaneous Collections. Vol. 76, No. 5: The Telescoping of the Cetacean Skull. By Gerrit S. Miller, Jr. (Publication 2720.) Pp. 70+8 plates. (Washington: Smithsonian Institution.)

University of London: University College. Calendar, Session 1923-1924. Pp. lxviii+10+423+lxix-clxxviii. (London.)

Agricultural Research Institute, Pusa. Bulletin No. 139: List of Publications on Indian Entomology, 1920-21. Compiled by the Imperial Entomologist. Pp. 67. (Calcutta: Government Printing Office.) 1 rupee.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. New Series, No. 17, October. Edited by W. F. Spear. Pp. 152. (London: Great George Street.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 36: Rural Education. By Katherine M. Cook. Pp. 35. Rural School Leaflet No. 12: Consolidation of Schools in Randolph County, Indiana. By O. H. Greist. Pp. 12. Rural School Leaflet No. 1[illegible]: The Consolidated Schools of Weld County, Colorado. By Prof. C. G. Sargent. Pp. 11. Rural School Leaflet No. 17: The Iowa Plan of Training Superintendents and Teachers for Consolidated Schools. By Mary Campbell. Pp. 5. (Washington: Government Printing Office.) 5 cents each.

Memoirs of the Asiatic Society of Bengal. Vol. 7, No. [illegible]: Vocabulary of Peculiar Vernacular Bengali Words. By F. E. Pargiter. Pp. [illegible]. (Calcutta: Asiatic Society of Bengal.) 4.8 rupees.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 11: Regenval in het Noordelijk deel van (Rainfall in the Northern part of) Sumatra's Oostkust. Door Dr. J. Boerema. Pp. iv+63+19 plates. (Weltevreden, Java: Albrecht and Co.)

Diary of Societies.

MONDAY, OCTOBER 29.

INSTITUTE OF ACTUARIES, at 5.—W. Palin Elderton and H. J. P. Oakley: Notes on the Interpretation of "Select" Rates of Mortality.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Actinomycosis: Madura Disease.

TUESDAY, OCTOBER 30.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Viscount Curzon: Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. C. E. K. Mees: Amateur Kinematography.

ROYAL SOCIETY OF MEDICINE, at 9.—Presentation of Gold Medal to Prof. Gowland Hopkins, who will lecture on Stimulants of Growth.

WEDNESDAY, OCTOBER 31.

SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—Sir W. M. Flinders Petrie: The Growth and Decay of Communities (Lecture).

THURSDAY, NOVEMBER 1.

ROYAL SOCIETY, at 4.30.—E. G. T. Liddell and Sir Charles Sherrington: A Comparison between certain Features of the Spinal Flexor Reflex and of the Decerebrate Extensor Reflex respectively.—J. Barcroft and H. Barcroft: The Blood Pigment of Arenicola.—T. Deighton: The Basal Metabolism of a Growing Pig.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at [illegible].—Major Wimperis: Some Recent Developments in Aircraft Instruments.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—W. Wilson: Industrial Research, with special reference to Electrical Engineering Development.

CHEMICAL SOCIETY, at 8.

FRIDAY, NOVEMBER 2.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Sir Westcott S. Abell: The Mechanical Problems of the Safety of Life at Sea. (Thomas Hawksley Lecture.)

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—S. J. Taylor: Photographic Perspective.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—D. V. Hotchkiss: Hydraulic Propulsion.

PHILOLOGICAL SOCIETY (at University College), at 8.—Prof. F. Newton Scott: American Idiom.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. H. Featherstone: A Critical Report on 100 cases of Spinal Analgesia with Tropacocaine.

SATURDAY, NOVEMBER 3.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10 A.M.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Dame Helen Gwynne-Vaughan: The Mechanism of Inheritance.

PUBLIC LECTURES.

SATURDAY, OCTOBER 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Legendary Folklore of the Sea.

MONDAY, OCTOBER 29.

UNIVERSITY COLLEGE, at 5.—Miss Iza Thompson: The Teaching of Speech to Deaf Children.

MEDICAL SOCIETY OF LONDON, at 5.15. Dr. C. K. Millard: The Disposal of the Dead. (Chadwick Lecture.)

WEDNESDAY, OCTOBER 31.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Major H. G. Anderson: Air Accidents and the Hygiene of Aviation.

UNIVERSITY COLLEGE, at 6.15.—H. Higgs: The Part of Statistics in Civic Education (Newmarch Lectures). (Succeeding Lectures on November 7, 14, 21, 28, and December 5.)

THURSDAY, NOVEMBER 1.

ROYAL SOCIETY OF MEDICINE, at 5.—Dr. A. Logan Turner: The Advancement of Laryngology: A Plea for Adequate Training and Closer Co-operative Action. (Semon Lecture.)

KING'S COLLEGE, at 5.30.—R. Aitken: The Geography of Spain and Typical Spanish Institutions. (Succeeding Lectures on November 8, 15, 22, and 29.)

FRIDAY, NOVEMBER 2.

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: The Fundamental Concepts of Natural Science. (Succeeding Lectures on November 9, 16, 23, 30, and December 7.)

SATURDAY, NOVEMBER 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. C. A. Raisin: Volcanoes.

NATURE

SATURDAY, NOVEMBER 3, 1923.

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Aeronautical Research.

"PROGRESS in aeronautical research has, throughout the year, been continuous but slow." This, the opening sentence of the report of the Advisory Committee for Aeronautics for the past year, indicates a measure of anxiety and leaves the impression that, in the view of the Committee, insufficient attention is being paid to the researches which it advises.

A further paragraph makes a note of the view that "Funds devoted to research by trained staffs will give a better return to the State than the offer of large sums as prize money for limited lines of attack on the problems of flight." The reference here is obviously to the prize offer of 50,000*l.* for a successful helicopter, and it would appear that the Aeronautical Committee dissociates itself from that scheme. In all these matters, however, and under the most favourable conditions, the Committee can only tender advice; all executive action rests with the Air Ministry.

In spite of a machine which, when dealing with scientific matters, grinds at every turn of the wheels, progress is reported in many directions. A wide range of subjects for research is dealt with but the degrees of urgency are very variable. There are problems connected with the trustworthiness of aero engines and their economical running. Fire prevention in aircraft is studied by a special sub-committee, and recommendations have been made which may be expected to reduce substantially this type of flying risk. The properties of metals, particularly in regard to fatigue, are receiving much attention in view of the fact that aeronautics depends for success on the building of light structures with a definite minimum of strength, and that the ordinary uses of metals in engineering practice do not call for a degree of refinement essential to aircraft construction. None of these problems, however, possesses the present importance and urgency of a closer examination of the aerodynamic properties of aeroplanes than has hitherto been attempted. Flight under critical conditions is required with the necessary instruments for accurate observation by a trained staff. The bottle neck of research occurs precisely at this point; for there is no specific allocation of staff for scientific research.

We have all had recent opportunities of observing the results of public inquiries into one or two cases of fatal accident arising during the use of civil aeroplanes. It may have been noticed that no blame is attached to individuals, and that the causes of the accidents are returned as unknown. In a certain sense no objection can be taken to such findings; indeed, they can be heartily endorsed so far as personnel is concerned. On

the other hand, it is believed that, so long as aeroplane design is based on unextended knowledge, so long will the consequences of human error in the piloting of an aeroplane be severe.

The preliminary cause of accident may be any one of a hundred and one things; in the great majority of cases the final steps leading to a crash are the same. An aeroplane cannot maintain itself in steady flight at a speed below a certain critical value called the "stalling speed," a value which in the commercial craft of the day is rarely less than 50 m.p.h. The direct consequence of this is unimportant, but the secondary effect is vital since at 45 m.p.h. such an aeroplane is uncontrollable. Usually the aeroplane first rolls violently, then puts its nose down and dives almost vertically into the ground at a speed of 70 to 80 m.p.h. The shock-absorbing mechanism fitted in the undercarriage never comes into operation.

Every pilot knows the sequence of events and tries to avoid stalling at the same time as he is anxious to reduce his speed when approaching unfavourable ground in a forced landing: in spite of skill, the inevitable error happens on an appreciable number of occasions. The rules for recovery from stalling are also perfectly well known, but in order to apply them the pilot requires a free fall of not less than 500 ft. If he is only 200 ft. from the ground the stalling of an aeroplane must lead to a crash. Must it always be so? The Aeronautical Research Committee does not think so, as may be seen from the following quotation:

"The results already achieved at the Royal Aircraft Establishment . . . are distinctly encouraging, particularly as regards the full scale experiments on stalled flight, and the Committee wish to pay a tribute to the skill shown by the pilots in their pioneer work.

"The present position is, however, that although maintained stalled flight is definitely possible, neither the stability nor the control of the aeroplane are such that flight near the ground may yet be regarded as safe, and since there do not appear to be any insuperable difficulties in the way, there is a very strong case for pushing forward. . . ."

Reading more fully in the report shows that the Committee believes in the possibility of ultimately designing aeroplanes which can be kept on an even keel in an emergency, and so touch the ground with apparatus specially introduced for taking the shocks of landing.

The Air Ministry has responded to the advice of the Committee to the extent of ordering two special machines for the necessary research. This is, we believe, the first time in the history of British aeronautical research that experimental conditions have had precedence in determining the design of an aeroplane, and the announcement of the fact by Sir Geoffrey Salmond at the Air Conference at the beginning of the year was generally welcomed and appreciated by all branches of scientific and technical activity in aeronautics. It will be some time before the aeroplanes are ready for use, and it is probably in relation to the conditions under which they will be used that the Aeronautical Research Committee has reason for anxiety. The present association of scientific research with routine experiment has been unfortunate, and the initiative in aeroplane design has—like the Schneider Cup—gone from Britain to America. All the important flight records, for speed, height and endurance, are held by the United States of America, together with the palm for energy devoted to research.

The situation does not appear to be one which will automatically right itself, and the belief is growing that the remedy will only come by placing a scientific man on the Air Council. British business instincts, if one may judge from such an example as that of the British Dyestuffs Corporation, still shy at the idea that scientific knowledge is required in the supreme administration, but events will probably determine the issue against them. In the meantime, one can only hope that the Aeronautical Research Committee will on later occasions be able to report that "progress is continuous" even if "slow." L. BAIRSTOW.

Biology at the Cross-roads.

Emergent Evolution: the Gifford Lectures delivered in the University of St. Andrews in the Year 1922. By Prof. C. Lloyd Morgan. Pp. xii+313. (London: Williams and Norgate, 1923.) 15*s*. net.

PROF. LLOYD MORGAN'S Gifford Lectures delivered at St. Andrews last year and now published are a constructive essay in evolutionary naturalism which, he warns us, Huxley would not accept, and that upon more counts than one. It is true that acceptance by Huxley, or by any one else, is inadmissible as a standard of reference for the verification of fact or theory in science; but the question at once arises: if the biological standards of an earlier generation are not those of to-day, wherein and why are they not? The occasion is not provided by Prof. Lloyd Morgan alone: in a multiplicity of forms the question echoes and re-echoes unanswered in the hearing of biologists who appear strangely inattentive alike to its insistence and its import. In the literature of systematic research, little enough of this appears; but in all kinds of periodicals less intensive and austere, and from all manner of platforms approachable by a public, ill-informed possibly, but

certainly inquisitive, the implied incertitude of biology provides unending material for thought.

It seems, indeed, that the technical literature has ceased to reflect the form and content of modern biological inquiry, for what else is the significance of the fact—if fact it is—that those who contribute preponderatingly to its mass and volume, workers and teachers in the universities, are, in their academic privacy, increasingly dubious concerning the fundamentals of their science? Tribute is still paid to the Darwinian theory, some of it good coin, most of it lip-service unwholesomely rich in ambiguity. Behind the Darwinian theory are its implications, very far-reaching, inescapable, but for the most part disregarded and feared. Still behind, entering into and doing more than a little to guide the course of discussion, a shady and scarcely mentionable background, is the fear of a democracy crudely godless. The kind of verbatim reporting and rapid snapshotting of Nature which to-day passes as biological research can lead at best to a mere reduplication of the universe: to a vast library edition of the facts of Nature, less rather than more orderly than the original, and less profitable to consult with advantage. But that does not mean that the mode of attainment or the constitution of scientific knowledge has changed since the middle of the nineteenth century, or that science owes any obligation to social exigency or individual composure. The present state of biology is not healthy.

We have brought these considerations to the reader's mind because they constitute the essential circumstances for the discussion of Prof. Lloyd Morgan's book. It is on their account that the two aims of the work must be distinguished. One is an examination of the ideas constituting the modern theory of relations to discover whether they may not yield something of value for biology: the other is a personal affair of the author and of such of his readers who, with him, hold the "proper attitude" of naturalism to be "strictly agnostic" and yet "cannot rest content" with it. It has always seemed to us that satisfaction with Prof. Alexander's view of deity is more intelligible in those who do not fully understand it than in those who do; but since this view, which Prof. Lloyd Morgan adopts, remains merely adjunct to his evolutionary theme, we propose to turn to the aspect of his work which is of greater biological interest.

The orderly sequence of natural events appears to present, from time to time, something genuinely new. Salient examples are afforded in the advent of life, of mind, and of reflective thought, while in the physical world it is beyond the wit of man to number the instances of "emergence." But if nothing new emerges, "if there be only regrouping of pre-existing events and nothing more, then there is no emergent evolution." Prof. Lloyd Morgan accepts the fact of emergence, and its examples, "with natural piety" (Alexander), which seems to mean little or nothing more than "the frankly agnostic attitude proper to science" (Lloyd Morgan).

Relations in Nature may thus establish additive or resultant characters, productive of quantitative continuity, and coexistent with emergence when it occurs, or emergent characters, which are qualitative, and always involve resultant effects also. In contradistinction to "the mechanistic dogma" the emphasis is not upon physics and chemistry, receptor-patterns and neurone-routes, but upon their "emergents," interrelation, as it were, in ever new relational orders. Modern physics has removed such a conception from the domain of metaphysics, and for better or worse it must be admitted, if not to the bosom, at least to the consideration of naturalism. The break is with vitalism, too, for "if vitalism connote anything of the nature of Entelechy or Elan—any insertion into physico-chemical evolution of an alien influence which must be invoked to explain the phenomena of life—then, so far from this being implied, it is explicitly rejected under the concept of emergent evolution." "Alien influx into nature is barred."

What Prof. Lloyd Morgan claims to be emergent is "some new kind of relation," and all new *kinds* of relation are incapable of prediction. Since relation is "the vaguest term in the philosophical vocabulary," it is well to understand the author's use of it. Relatedness includes not only the relation-of-terms but also the terms-in-relation. An atom is an instance of relatedness; so, too, is an organism. "Any concrete situation in which entities play their part, each in respect of others, is an instance of relatedness." The relations upon which each emergent entity depends are intrinsic; new extrinsic relations accompany its emergence, the two kinds co-existing "inseparably in concrete fact." Change is continuous: "the concrete world we seek to interpret is a going concern; . . . there is a carrying forward of old relations and the emergent advent of new relations."

From this point an effort is made to meet the metaphysical position in regard to the priority of mind to relations. Terms and relations spring into existence together. Throughout his treatment of relatedness, Prof. Lloyd Morgan moves with the New Realists. The heart of the matter for biology lies in what the logicians call the *sense* of relations, deemed here to be determined by natural direction, and in the characters of three-entity situations. Concerning the first, the author sees even in the thought-process a spacial

direction "in the vital and the physical events which are correlated with it." Concerning the second, he says we may have not merely "the additive resultant of this duality *plus* that; but something more in their combination to constitute an integral whole."

Consciousness is to receive further treatment in a second course of lectures, but under the subject of "reference" we have some hints concerning the writer's naturalistic attitude. The analysis of relatedness at the level of consciousness is difficult, because consciousness is a correlate of vital relatedness at a very advanced stage of its evolutionary progress, "requiring the effective go of life as that requires the primary go of physical events, . . . linked with emergent qualities at so high a level, and involving so many kinds of relatedness of lower orders." There follows an able discussion of reference below the level of reflective consciousness, from which Prof. Lloyd Morgan proceeds to his view of "projicience," perceptual reference to a distance (Sherrington), reference of all objective characters to things at a distance (Lloyd Morgan). Projicience, he says, begins "when mind or consciousness is supervenient in the course of evolutionary progress, and takes definite form only when distance-receptors are differentiated on the plane of life. It presupposes the evolution of mind as an emergent quality of the psychical system correlated with the physical system of the organism." Mind is emergent in evolutionary history. When it comes, the "particular go" of events at the level of its advent is altered. This is so with all emergents. "So long as the words are used in a purely naturalistic sense, one may say that the higher kinds of relatedness guide or control the go of lower-level events."—We are not sure that that is not rather a dangerous sentence. What is the naturalistic sense of "guiding" and "controlling"? The question comes back to us in reading the chapter on causation and causality, where Prof. Lloyd Morgan is under some difficulty to rescue the concept of causation (or rather "causality" as better adapted to his theistic position as we understand it) from the clutches of Mach and Bertrand Russell, who both desire the extrusion of the word "cause" from the philosophical vocabulary.

We have neglected the author's theism for the exposition of his naturalism because he himself regards the former as "supplementary." It is to be hoped that impatience with the crudity of much in current biological literature has not closed our eyes to opposite excess in Prof. Lloyd Morgan's work, which, rightly understood, affords encouragement for the rehabilitation of biology on strictly naturalistic lines.

TUDOR JONES.

Mathematical Astronomy.

(1) *Cours de mécanique céleste.* Par Prof. H. Andoyer. Tome 1. Pp. vi + 439. (Paris: Gauthier-Villars et Cie, 1923.) 50 francs.

(2) *Cours d'astronomie. Faculté des Sciences de Paris.* Par Prof. H. Andoyer. Première partie: Astronomie théorique. 3ᵉ édition entièrement refondue. Pp. iii + 455. (Paris: J. Hermann, 1923.) 35 francs.

(3) *Grundriss der theoretischen Astronomie und der Geschichte der Planetentheorien.* Von J. Frischauf. Dritte vermehrte Auflage. Pp. xvi + 248. (Leipzig: Wilhelm Engelmann, 1922.)

(1) THE subject of celestial mechanics is distinguished alike by the profound difficulty and the beauty of its problems. For more than two centuries it has been the object of research on the part of the most eminent mathematicians. Its literature, both in the form of theoretical and critical studies and of the most extensive practical calculations ever undertaken, is vast. For the most part the memoirs naturally presuppose a general familiarity with established methods and are concerned with special phases of the subject. They will always leave room for the treatise aiming at a more introductory and systematic exposition. It may appear that in a field so intensively cultivated certain classical lines would have become firmly established, to the exclusion of any fresh and original treatment; that the possibilities open to the writer of a new treatise would have been largely exhausted. That would be to undervalue the richness of the field completely. We are certainly fortunate in the possession of several such systematic treatises, of the highest quality. But when they are brought together, in all languages, they make no excessive number. It is probably safe to assert that no other branch of science is so completely free from superfluous works of this kind. Nor is the reason far to seek. There is no mercenary incentive to their production, and the only motive must be allied with sincerity of purpose.

When therefore Prof. Andoyer modestly refers in his preface to the rashness of his undertaking after the works of Tisserand and Poincaré, he need not be taken seriously at all. Tisserand's is a most beautiful work of exposition, original rather in form than in matter. Poincaré's "Méthodes nouvelles" is a work of original genius, which left its author still free to find independent fields for his "Leçons." The very distance which separates these works in scope and manner would make it strange if they had exhausted the possibilities of the subject for systematic treatment, and it is not true. It is indeed most effectively

disproved by Prof. Andoyer's work, of which the first volume is now published. The author is not only an accomplished mathematician, whose official position places him in direct contact with the work of astronomical computation on the widest scale, but he is also one who has displayed an altogether exceptional faculty in the arid task of calculating mathematical tables. He is therefore in an excellent position to make an instructive contribution to the subject of celestial mechanics, and his work will be received with gratitude.

The present volume is largely concerned with the theory of the determination of orbits. This may suggest comparison with several classical works on that subject. But the treatment it receives here is distinguished by its manner of combining two distinct points of view. The practical nature of the problem is always insisted on, and the needs of the astronomical computer are served by numerical examples drawn from actual practice. At the same time the subject is treated not as a mere precursor, but as an integral part of celestial mechanics. Thus the points of fundamental importance receive a much more critical discussion than has been usual in those treatises which have a more restricted practical outlook. A short digression on the method of least squares is inserted for the determination of a Keplerian orbit based on any number of observations, and a more elaborate section on the theory of interpolation leads up to the calculation of perturbations by numerical quadratures under several forms.

The volume concludes with two chapters, one developing the series relative to elliptic motion and the other dealing with the expansion of the disturbing function, as required in the theory of the major planets. The second volume, which will complete the work, will deal with the theory of the moon, the rotations of the earth and of the moon, and the theory of the Galilean satellites of Jupiter. The whole will form a very valuable contribution to a subject of which the interest, being many-sided, will not easily be exhausted.

(2) Prof. Andoyer's "Cours d'astronomie," of which the first volume now appears in a considerably modified form, has reached its third edition. To this sufficient evidence that it has met with a favourable reception in France, it may be added that it is an excellent example of the class of work to which it belongs. Its subject is what is generally known in England as spherical astronomy, though geometrical astronomy would be a more appropriate name with proper regard to its matter and its methods. The function of such works is to provide for the student, who already possesses the necessary mathematical equipment, an avenue to an exact knowledge of astronomy, apart from any deep acquaintance with celestial mechanics. Thus the contents of the present volume may be summarised under its four sections. The first book provides an introduction to spherical trigonometry and spherical co-ordinates in general. The second introduces the usual systems of astronomical co-ordinates and time, and explains the reductions for refraction, parallax, and aberration. Precession, nutation, and time form the main subjects of the third book, which begins with an outline of the ideas of dynamical astronomy; a complementary chapter on the determination of an orbit from three observations (Lagrange's method) might be transferred from the end of the volume, if indeed the inclusion of this chapter can be justified at all. The fourth and last book deals very fully with the calculation of eclipse phenomena, and the volume ends with a note on the ecclesiastical calendar. It will be seen that these topics mainly follow familiar lines of choice, and, as would be expected from the author, the treatment is throughout sound and scholarly.

Rightly or wrongly, we approach this work from the point of view of the general mathematical student rather than of the professional astronomer. The latter, as a specialist, must be prepared to dig deep for his knowledge. The former will find here a selection of fundamental problems treated with fullness and academic elegance. Whether such a work will inspire him with a true and abiding interest in astronomy appears more doubtful. The author is probably addressing himself to a more advanced type of student than we have in mind, and nothing could be more unjust than to express disappointment with a work on the ground that it does not fulfil a purpose which was never intended by the writer. There is, however, room for an introduction to astronomy addressed to the mathematician who has no professional aim in the science, and for the ideal book of this kind we may still have long to wait.

(3) Dr. Frischauf's work has also reached a third and enlarged edition, but in this case the first edition appeared more than fifty years ago. This vitality it owes to genuine merit, for in a short compass it has provided a succession of German students with a concise and lucid introduction to the problems involved in the determination of orbits. The elementary section on Keplerian motion follows closely the lines of the *Theoria Motus*, and the practical methods which are then explained are those of Olbers for the parabolic orbit and of Gauss for the elliptic orbit. The outlook is thus in a sense restricted, though the modifications introduced by Gibbs are explained and some indication is given of the method of calculating perturbations by mechanical quadratures. But the distinguishing feature of the work lies in its historical sections, which

trace the development of planetary theory from the time of the Greeks through Kepler to Gauss. In no sense is this account complete, any more than that of the modern methods of calculating orbits. It is nevertheless well that the student should have a clear idea of the Ptolemaic system and of the actual steps by which Kepler was led to his epoch-making discoveries. Without its historical background the study of astronomy loses much of its interest, and the realisation of this fact has probably much to do with the continued demand for Dr. Frischauf's book, which is to be inferred from its reappearance. H. C. P.

Medieval Science.

A History of Magic and Experimental Science during the First Thirteen Centuries of our Era. By Prof. Lynn Thorndike. Vol. 1. Pp. xi+835. Vol. 2. Pp. vi+1036. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 2 vols., 10 dollars. 42s. net.

THE very important work recently issued by Prof. Thorndike is a monument of learning scientifically marshalled. It marks a period in the history of medieval studies, which it will influence in somewhat the same way that anthropology has been affected by "The Golden Bough," a book with which it has many parallels. Prof. Thorndike has produced a work which in every sense is worthy of the name of "scientific." He carries on the exploration of magical ideas beyond the level of civilisation at which anthropologists are accustomed to stop, and he demonstrates the same ideas current in the highly sophisticated atmosphere of the scholastic Middle Ages.

From the title over the introduction to the work, namely, "A History of Magic and Experimental Science and their Relation to Christian Thought," etc., the reader might be led to expect a polemical exposition of a definite point of view towards some of the great problems of human existence. Prof. Thorndike, however, presents us with an immense collection of facts with the object of adding to our knowledge of the history of thought, rather than of proving any previously formulated thesis. "Magic," "Experimental Science," "Christian Thought" are rather chosen as headings to help the student towards evolving some order in the mass of material. The conceptions expressed by each of these modern terms can in turn throw a further light on the history of thought, for it is ideas rather than the practices to which they lead on which Prof. Thorndike has focussed his discussion. "Magic represented a way of looking at the world. In the case of primitive men and savages it is possible that little thought accompanied their action." But until such thought develops a purposive and rational basis, the doings of man cannot be distinguished as either religious or scientific or magical. Even magic implies such purposive mental states, and so may be viewed from the point of view of the history of thought.

An attempt is made to trace a relationship of some of the most important manifestations of mental life during the long period under consideration. Thus in one age Prof. Thorndike finds the germ of conceptions more fully developed by another generation, and gradually undergoing profound modification through succeeding years. More than half of the work deals with the twelfth and thirteenth centuries, but the author fully justifies his contention that this period can only be understood when viewed as the outcome of Greek, Latin, and early Christian thought.

The broad survey of the book enables us to consider human thought throughout the period considered as something like an organic whole. The sense of continuity and interrelationship is strong throughout. "It seems to me," says Prof. Thorndike, "that in the present stage of research into and knowledge of our subject, sounder conclusions and even more novel ones can be drawn by a wide comparative survey than by a minutely intensive and exhaustive study of one man or of a few years." It would be a mistake, however, to think that no intensive study has gone to the preparation of these volumes. They are indeed a mine of erudition, and will be indispensable for reference by all who have to treat of medieval life or thought. They present a repertory of what is known as to the lives and works of an immense number of Western writers up to the fourteenth century, and an invaluable record of the whereabouts of much unpublished material scattered throughout the great libraries of Europe. Nor is the study limited to well-known names. Thus, the reviewer has long been interested in an obscure text of English origin known as the "Secreta Philosophorum," which combines in heterogeneous fashion technical and chemical recipes, conjuring tricks and riddles, mathematical and musical lore, and astronomy. This entertaining work, though it enjoyed considerable popularity in fourteenth- and fifteenth-century England, has hitherto been overlooked by medievalists. But it has not escaped the vigilance of Prof. Thorndike, who gives an interesting and succinct account of its contents, and has observed that it embodies a composition by the thirteenth-century Italian writer, Peter the Pilgrim, on the magnet and its use as a compass. The point is of some importance, as Peter Peregrinus was the first writer on the mariner's compass whose works have come down to us.

This stray example could no doubt be paralleled by the experience of many students who will find in Prof.

Thorndike's pages material throwing light on their own special studies. Medieval students may indeed be congratulated on the appearance of a work which will lighten their labours and illumine their path. Nor is it only the specialist to whom it will appeal. Many are puzzled by the extravagant claims sometimes made to-day for the "Middle Ages." An attempt to penetrate the mass of medieval literature will probably produce a strong reaction from any such conceptions, but the ordinary reader is liable to retire vanquished before he has covered a tithe of the material or gained any broad view of its course. Such readers will be grateful to find in these volumes a thoroughly readable presentation of medieval thought, while every page provides evidence of the sources where each statement may be verified. The admirably full and well-arranged indices are a very welcome element. Prof. Thorndike's work undoubtedly takes rank as an important contribution to the history of civilisation.

DOROTHEA WALEY SINGER.

Chemical Works of Reference.

(1) *A Comprehensive Treatise on Inorganic and Theoretical Chemistry.* By Dr. J. W. Mellor. Vol. 3: *Cu, Ag, Au, Ca, Sr, Ba.* Pp. x+927. (London: Longmans, Green and Co., 1923.) 63*s.* net.

(2) *A Dictionary of Applied Chemistry.* By Sir Edward Thorpe. Vol. 4: *L-Oxydisilin.* Revised and enlarged edition. Pp. viii+740. (London: Longmans, Green and Co., 1922.) 60*s.* net.

(3) *Text-book of Inorganic Chemistry.* Edited by Dr. J. Newton Friend. Vol. 9, Part 1: *Cobalt, Nickel, and the Elements of the Platinum Group.* By J. Newton Friend. (Griffin's Scientific Text-books.) Second edition, revised. Pp. xxv+367. (London: C. Griffin and Co., Ltd., 1922.) 18*s.* net.

(1) THE third volume of Dr. Mellor's great treatise deals with the two triads, copper, silver, gold, and calcium, strontium, barium. In a work of reference the order in which the elements are taken is of less importance than in a text-book, but the scheme adopted in this volume has certain disadvantages. By considering the alkaline earths as a group, the author has been able to bring together on one page the ternary diagrams for the systems $CaO-CaCl_2-H_2O$, and $SrO-SrCl_2-H_2O$, and in general has secured the advantage of being able to describe the strontium and barium salts as variants of the more familiar calcium salts; but this close association of the metals of the three alkaline earths makes it all the more remarkable that the element magnesium is not even included in the same volume, so that magnesite and calcite are separated as widely as possible from one another. The interpolation of copper, silver, and gold between the alkalies and the alkaline earths is, of course, a concession to the law of octaves as expressed in Mendeléeff's series of thirteen short periods.

In addition to the disadvantage of separating the alkalies and the alkaline earths, the arrangement suffers from the drawback that copper, silver and gold may be regarded as forming a first stage in the winding up of the anomalies of the metals of the transition series. They therefore exhibit, in an attenuated form, the influence of the phenomena of co-ordination, which dominates so fully the chemical properties of the elements which immediately precede them in the periodic classification. It is therefore a real disadvantage that the wide range of amines and of double salts which are formed by these metals are described at a stage when the theory of co-ordination has not yet been discussed.

In his preface the author states that he has been much pleased with the general reception which the first two volumes have received. The reviewer can confirm from his own experience the value of the author's treatise, even at the present stage, when scarcely half of the work is available for reference, and is confident that the treatise when complete will be of very great service to all serious students of inorganic chemistry.

(2) The fourth volume of the new edition of the "Dictionary of Applied Chemistry" covers the section from L to O, with the exception that the articles on oxygen, ozone, etc., are held over for a later volume. In the section now published there has been a considerable expansion, from 600 to 740 pages. While most of the principal articles in the volume have contributed something to this increase of length, the most notable changes are to be found in the series of articles under the heading "Nitrogen." The article on nitrogen itself does not appear to have been altered very greatly; but in writing the section on the manufacture of nitric acid, Prof. Hart has secured the collaboration of Dr. F. C. Zeisberg, of Du Pont de Nemours and Company, and a completely new series of diagrams is given to illustrate modern practice in the manufacture of this acid. In addition to this, the earlier article on the utilisation of atmospheric nitrogen has been replaced by an article of nearly three times the length by Prof. J. R. Partington, in which a much fuller account is given of the various processes for the fixation of nitrogen and of the methods used for the oxidation of ammonia to nitric acid.

(3) The second edition of Dr. Friend's text-book requires only brief comment, since very little alteration has been made in the book, apart from the addition of some notes on the detection and estimation of the platinum metals. It is, however, noteworthy that the

periodic table, which forms the frontispiece of the volume, does not give the atomic numbers of the elements—an omission which should certainly be rectified when a further edition of any of these volumes is called for. The value of this particular volume would also be much increased by a fuller appreciation of the part played by co-ordination in the formation of so many of the compounds of this group of elements.

Our Bookshelf.

Electrons, Electric Waves and Wireless Telephony: Being a Reproduction with some Amplification of the Christmas Lectures (96th Course) delivered at the Royal Institution of Great Britain, December, 1921, January, 1922. By Prof. J. A. Fleming. Pp. viii + 326. (London: The Wireless Press, Ltd.; New York: The Wireless Press, Inc., 1923.) 7*s.* 6*d.* net.

Simple and excellent descriptions are first given of the phenomena which take place when waves are produced in liquids and gases. The author then gives an account of the architecture of atoms as imagined by modern physicists. The Rutherford atom is taken as the standard and the Planck-Bohr method, in which atoms are supposed to radiate energy, is described. The concluding portion of the book is on radio-telephony and will be very helpful to the intelligent amateur.

Prof. Fleming's discussions are on orthodox lines, but we were disappointed that he does not throw more light on the mechanism of Planck's quantum theory. Many of the numerical results obtained are wonderful and are corroborated in the most marvellous way by other methods. But the *modus operandi* is still a mystery. In describing the Michelson-Morley experiment it is stated that it proves clearly that the velocity of light is independent of the motion of the source of light or of the observer. We are not justified, however, in accepting this statement if an explanation can be given which satisfies the accepted canons of mechanical science. Such an explanation was given by Fitzgerald. The dragging in of space and time "frames of reference" does not help the ordinary reader. We are glad the author adheres as far as possible to the laws of classical dynamics. Some men of science are wondering how much of modern theory will remain when all the laboriously constructed scaffolding is removed.

Poems of Science: Pages of Indian Earth History. By K. A. Knight Hallowes. Pp. xii + 40. (London: Erskine Macdonald, 1923.) n.p.

Mr. K. A. Knight Hallowes has worked for eighteen years on the staff of the Geological Survey of India, and the beauty and dignity of the country that he has studied have appealed to his poetic sense. In a series of sonnets, he touches on the origins and the decay of the rocks that control some of the noblest scenery of the earth; and again and again the bright hue of a delicate flower, springing from some cleft in a forbidding plateau or a torrent-carved ravine, lifts his thoughts from the earth to the great Mystery that is worshipped under many names. We must not expect Wilde's

> O lonely Himalayan height,
> Grey pillar of the Indian sky,

or

> The almond groves of Samarcand,
> Bokhara, where red lilies blow;

but we cannot help remembering what use Marlowe made of the resonant names that reached him from the East. Mr. Hallowes does not rise above the Gazetteer of India with such lines (p. 23) as "In Burma, in the district of Magwe." The seventh sonnet shows, however, that he has achieved a mastery over a difficult form of verse, and the simple opening lines, oddly enough recalling Dante, lead on to effective geological expression at the close. Elsewhere the "science" is a little clouded by such phrases as "molten fire" and "powers exhibited by flame in bygone time." The eleven words describing foliation in Sonnet XV. are accurate enough, but leave the layman somewhat cold.

Ergebnisse der exakten Naturwissenschaften. Herausgegeben von der Schriftleitung der *Naturwissenschaften.* Pp. iv + 403. (Berlin: Julius Springer, 1922.) 10*s.* 5*d.*

The first annual volume of this new review of the exact natural sciences covers an immense territory in a very thorough manner; and it is evident that this, and the future volumes, will be an essential requisite in every physical library. Astronomy, relativity, statistical mechanics, the vibrations of rotating shafts, Nernst's thermal law, radiation, contact potential, chemical kinetics, photochemistry, electrolytic dissociation, X-ray spectroscopy, crystal structure, atomic and spectral theory, the theory of band spectra, photoelectricity and photoluminescence, and the periodic system of the elements are treated by authorities who have contributed to the recent remarkable developments of the subjects with which they deal. In this initial volume most of the reviewers have attempted to give a general account of the present state of the subjects reviewed, and the bibliographies which accompany their papers appear to be very comprehensive. The latter should prove very valuable; they cover the ground up to 1922, and include work by English and American physicists, the value of which is fully recognised in the text. Future volumes will be devoted more specifically to progress made during the year under review, the object being to give a general view of the progress made without details of individual publications.

Opere di Paolo Celesia. Serie scientifica a cura di F. Raffaele della R. Università di Roma. Studi biologici. Con prefazione di Osvaldo Polimanti. Pp. xii + 426. (Roma: Dr. G. Bardi, 1923.) n.p.

Paolo Celesia was born at Genoa in 1872 and died in Rome in 1916. He was attracted to the study of natural science and began his scientific training in the laboratory of comparative anatomy in Genoa, and soon took up the investigation of the sponge Suberites and its symbiosis with the hermit crab Pagurus, his account of which forms the first paper

in this volume. He then turned to experimental work on the ventral nerve-cord of the rock-lobster Palinurus, and on the reflex mechanism of the chela of the crayfish. He built a private laboratory on the shore of Lake Como, but his scientific work was interrupted by another project—he founded the *Rivista di Scienze biologiche* and wrote for it many critical articles and reviews. The death of his father and of his faithful laboratory assistant caused him to suspend his researches, and he turned largely to philosophy. His friends have decided to reprint a selection of his earlier papers and of his unpublished work, and the present volume, which is excellently produced, forms the first instalment. It consists of eleven original papers—on the subjects noted above and on graft hybrids, their significance in regard to heredity and acquired characters, the transformation of the wild bee into the hive bee, etc.—sixteen reviews and articles, and a reprint of his thesis on progressive heredity.

Handbuch der Zoologie: eine Naturgeschichte der Stämme des Tierreiches. Begründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. Erster Band: Protozoa, Porifera, Cœlenterata, Mesozoa. Erste Lieferung. Pp. 192. (Berlin und Leipzig: Walter de Gruyter und Co., 1923.) 9*s.*

THIS forms the first part of Vol. I. of a handbook of zoology, to be completed in five volumes, in the preparation of which about forty authors have agreed to take part. An introduction (50 pp.) to the Protozoa by Prof. Rhumbler is followed by an account (60 pp.) of the Rhizopoda by the same author and of the Flagellata by Dr. V. Jollos, and by the first few pages of the section on the Sporozoa by Prof. M. Hartmann. After the general account of each order is given a scheme of classification into sub-orders, groups, families, and, in some cases, genera, with short diagnoses of each. While the treatment of most of the groups is adequate, the very brief account of Entamœba is not consonant with the importance of this genus, of which no figure is given. The latest references in the list of works on Rhizopoda relate to papers published in 1916, and this suggests that publication has been delayed. The section on the flagellates contains a number of good new figures, and the list of references includes papers published in 1921 and 1922, but the account of the collared flagellates is very short and inadequate.

Plane Geometry for Schools. By T. A. Beckett and F. E. Robinson. Part II., with Answers. Pp. viii + 241-453 + v. (London: Rivingtons, 1922.) 5*s.*

MESSRS. Beckett and Robinson's interesting attempt to combine the main propositions of formal geometry with the extensions included in the easier portions of "modern plane geometry" and with the fundamental notions and applications of trigonometry, is continued in the second part of their work. The first part was noticed in these columns on June 10, 1922 (vol. 109, p. 737). The second part consists of three sections. Section iv. deals with areas, extensions of Pythagoras's theorem, and the properties of chords and tangents of circles, with incidental reference to radical axis, graphical solution of quadratic equations, etc. In section v. we have inequalities, maxima and minima, and regular polygons. Section vi. deals with ratio and proportion: applications to trigonometry are then given, as well as centres of similitude, inversion, pole and polar (with a little on anharmonic ratio). The treatment is pleasant and masterly, and the whole work can be highly recommended. S. B.

Printing Telegraph Systems and Mechanisms. By H. H. Harrison. (Manuals of Telegraph and Telephone Engineering.) Pp. xii + 435. (London: Longmans, Green and Co., 1923.) 21*s.* net.

THIS volume will be most useful as a work of reference to designers of telegraph machinery. It will also be useful as a text-book in telegraph administrations. The book has been very carefully compiled; the diagrams, of which there are 420, are excellent, and the latest modern applications including high frequency multiplex methods, both for land and submarine cables, are fully described. There is now considerable overlapping of the sciences of telephony, telegraphy and radio-communication, many of the same devices being used in each. It must be admitted that at present, development in all branches of the art of communication is taking place most rapidly in the United States. Communication service in that country is such a large undertaking that systematic research can be carried on intensively on a scale that excites the wonder and envy of European engineers. In Britain, the home demand for apparatus is comparatively on a much smaller scale.

Experimental Physical Chemistry for Students in the Medical and Allied Services. By Dr. B. S. Neuhausen. Pp. 53. (Philadelphia: H. N. Rudley, 614 Arch Street, 1923.) 1 dollar.

DR. NEUHAUSEN'S work is in the form of a pamphlet rather than of a book. The physio-chemical exercises which he describes are all related directly to biochemistry or medicine; thus, measurements of freezing-point depression, electrical conductivity, the concentration of hydrogen, sodium and chlorine ions, viscosity, refractive index, etc., are all carried out with serum rather than with more commonplace solutions; and the rate of inversion of cane-sugar is studied in the form of an inversion by invertase in place of the more familiar inversion by acids. In view of the growing importance of physical measurements in biochemistry the appearance of a work of this character may be heartily welcomed.

A Text-book of Physics. By Dr. R. S. Willows. Third edition. Pp. viii + 48 + 488. (London: E. Arnold and Co., 1923.) 9*s.* net.

THE call for the third edition of this useful text-book has given the author an opportunity to add a chapter on the conduction of electricity through gases. The McLeod gauge is first described and a brief account is given of the electric discharge in a vacuum tube. Then follow experiments on kathode rays and positive rays, and paragraphs dealing with X-rays, ionisation in gases and radioactivity. A chapter of a similar kind on electromagnetic waves may be suggested for a future edition.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Psycho-Analysis and Anthropology.

THE infection by psycho-analysis of the neighbouring fields of science—notably that of anthropology, folklore, and sociology—has been a very rapid and somewhat inflammatory process. The votaries of Freud, or some among them, have displayed in their missionary zeal an amount of dogmatism and of aggressiveness not calculated to allay the prejudice and suspicion which usually greet every new extension of their theories. Some of their critics, on the other hand, go so far as to dismiss all anthropological contributions of Freud and his school as "utterly preposterous" and "obviously futile," as "an intrigue with Ethnology which threatens disaster to both parties," as "a striking demonstration of *reductio ad absurdum*" (Prof. Elliot Smith in Rivers's "Psychology and Politics," pp. 141-145). This is a harsh judgment and it carries much weight, coming from one by no means hostile to psycho-analysis and thoroughly well acquainted with anthropological problems, especially those discussed by Freud and his school. This seems the right moment to consider impartially, without enthusiasm or prejudice, the scope, importance, and value of Freud's contribution to anthropology.

Through the initiative and under the direction of Prof. Seligman, who at that time was engaged in practical psycho-analysis of war neuroses, I have been able to apply some of Freud's conclusions directly to savage psychology and customs, while actually engaged in field-work among the natives of Eastern New Guinea.

Freud's fundamental conception of the Œdipus complex contains a sociological as well as a psychological theory. The psychological theory declares that much, if not all of human mental life has its root in infantile tendencies of a "libidinous" character, repressed later on in childhood by the paternal authority and the atmosphere of the patriarchal family life. Thus there is formed a "complex" in the unconscious mind of a parricidal and "matrogamic" nature. The sociological implications of this theory indicate that throughout the development of humanity there must have existed the institution of individual family and marriage, with the father as a severe, nay, ferocious patriarch, and with the mother representing the principles of affection and kindness. Freud's anthropological views stand and fall with Westermarck's theory of the antiquity and permanence of individual and monogamous marriage. Freud himself assumes the existence at the outset of human development, of a patriarchal family with a tyrannical and ferocious father who repressed all the claims of the younger men (*cf.* "Totem and Taboo," chap. iv. 5, and "Massen-Psychologie und Ich-Analyse," chap. x.). With the hypothesis of a primitive promiscuity or group marriage, Freud's theories are thoroughly incompatible, and in this they have the support, not only of Westermarck's classical researches, but also of the most recent contributions to our knowledge of primitive sexual life.

When we come to examine in detail the original constitution of the human family—not in any hypothetical primeval form, but as we find it in actual observation among present-day savages—some difficulties emerge. We find, for example, that there is a form of matriarchal family in which the relations between children and progenitors do not exist in the typical form as required by Freud's hypothesis of the Œdipus complex. Taking as an example the family as found in the coral archipelagoes of Eastern New Guinea, where I have studied it, the mother and her brother possess in it all the legal *potestas*. The mother's brother is the "ferocious matriarch," the father is the affectionate friend and helper of his children. He has to win for himself the friendship of his sons and daughters, and is frequently their amicable ally against the principle of authority represented by the maternal uncle. In fact, none of the domestic conditions required for the sociological fulfilment of the Œdipus complex, with its repressions, exist in the Melanesian family of Eastern New Guinea, as I shall show fully in a book shortly to be published on the sexual life and family organisation of these natives.

Again, the sexual repression within the family, the taboo of incest, is mainly directed towards the separation of brother and sister, although it also divides mother and son sexually. Thus we have a pattern of family life in which the two elements decisive for psycho-analysis, the repressive authority and the severing taboo, are "displaced," distributed in a manner different from that found in the patriarchal family. If Freud's general theory is correct, there ought to be also a change in the thwarted desires; the repressed wish formation ought to receive a shape different from the Œdipus complex.

This is as a matter of fact what happens. The examination of dreams, myths, and of the prevalent sexual obsessions reveals indeed a most remarkable confirmation of Freudian theories. The most important type of sexual mythology centres round stories of brother-sister incest. The mythical cycle which explains the origin of love and love magic attributes its existence to an act of incest between brother and sister. There is a notable absence of the parricidal motive in their myth. On the other hand the motive of castration comes in, and it is carried out not on the father but on the maternal uncle. He also appears in other legendary cycles as a villainous, dangerous, and oppressive foe.

In general I have found in the area of my studies an unmistakable correlation between the nature of family and kinship on one hand and the prevalent "complex" on the other, a complex which can be traced in many manifestations of the folklore, customs, and institutions of these natives.

To sum up, the study of savage life and some reflection on Freud's theories and their application to anthropology have led me to the conviction that a great deal of these theories requires modification and in its present form will not stand the test of evidence—notably the theory of *libido*, the exaggeration of infantile sexuality, and the manner in which "sexual symbolisation" is dealt with. The character of the argumentation and the manner and mannerisms of exposition moreover often contain such glaring surface absurdities and show such lack of anthropological insight that one cannot wonder at the impatience of a specialist, such as expressed in the remarks of Prof. Elliot Smith quoted above. But with all this, Freud's contribution to anthropology is of the greatest importance and seems to me to strike a very rich vein which must be followed up. For Freud has given us the first concrete theory about the relation between instinctive life and social institution. His doctrine of repression due to social influence allows us to explain certain typical latent wishes or "com-

plexes," found in folklore, by reference to the organisation of a given society. Inversely it allows us also to trace the pattern of instinctive and emotional tendencies in the texture of the social fabric. By making the theories somewhat more elastic, the anthropologist can not only apply them to the interpretation of certain phenomena, but also in the field he can be inspired by them in the exploration of the difficult borderland between social tradition and social organisation. How fruitful Freud's theories are in this respect I hope to demonstrate clearly in the pending publication previously mentioned.

BRONISLAW MALINOWSKI.
Department of Ethnology,
London School of Economics,
University of London.

Spectra of Isotopes.

THE quantum theory of line spectra developed by Bohr has been most successful in explaining the spectrum of hydrogen and helium, and by a further hypothesis the spectra of the alkali metals. By asserting that elliptic orbits are possible, as well as circular orbits, Sommerfeld succeeded in explaining the Stark and Zeeman effects and the fine structure of spectral lines. It is significant that Bohr's equation for the frequency of the spectral series also explains the difference between the series spectra of isotopes of the same element. The experiments of Aronberg and Merton on the structure of 4058 Å. of isotopes of lead showed, however, a remarkable discrepancy between the shift predicted by the theory and that actually observed. Similarly Merton's experiments on the line 6708 of lithium showed that the line consisted of two components 0·151 Å. apart, while the theoretical shift was 0·087 Å. The quantum theory is unable to account for this large separation observed.

Recently Ehrenfest, commenting upon the validity of the simple Bohr equation, remarked that the equation cannot be true in general for atoms with several electrons, as in this case the radiating electron compels the remaining electrons to execute the motions of reaction which influence the nucleus. Moreover, Nicholson has shown that, by the choice of simpler orbits and by the supposition made by Sommerfeld, as to invariability of energy W for all possible orbits, the inner orbit has a radius of about one-tenth of that of the outer orbit. It has thus been shown that the external electron moves in the field of the nucleus, which is asymptotically a Coulomb field, and that Bohr's formula cannot be far wrong for a rough determination of the separation to be looked for in the spectra of isotopes.

Prof. McLennan, however, in an account of interesting experiments (Proc. Roy. Soc. A 714, p. 33, and A 711, p. 342) on the structure of the line 5460 of mercury and the line 6708 of lithium, and isotope displacement, has found that when the radiation constituting the green line of mercury is passed through moderately luminous vapour, the main component and components $+1$ and -1 are distinctly absorbed. In an attempt to explain the complex structure of the lines from the point of view of the isotopic structure of the elements, the view is put forward that the spectral displacement for isotopes should be given by the atomic number multiplied by the displacement calculated on Bohr's theory, and the main components of 5460 are attributed to isotope 200, and the component $+1$ and -1 to isotopes 198 and 202 respectively.

In the light of the recent experiments of Bronsted and Hevesy, who succeeded in separating the isotopes of mercury, and showed also that the isotopic composition of mercury of terrestrial origin is the same, it is difficult to conceive why, in Prof. McLennan's experiments, the lines corresponding to isotopes 198, 200 and 202 should alone be absorbed, while the lines corresponding to the other isotopes are not absorbed. Further, if, according to Aston's experiments, isotopes 197–200 exist in mercury in largest proportion, one would naturally expect that the most intense component of 5460, that is, the main component, should naturally correspond to isotope 197. Similarly in the case of lithium, he found that the line 6708 consists of a quartet, the average displacement of one doublet being about 3 to 4 times as great as the calculated separation, namely, 0·087. But generally it is found that enhanced lines are developed when an arc is operated in vacuo, thereby showing that it cannot be supposed that these lines are true arc lines, which is in conformity with Nicholson's view that the radiation 6708, which McLennan examined, might be the principal spark line of lithium, which has a value very close to 6708.

These facts naturally lead one to question whether McLennan's view has real physical significance. To settle this point a careful examination of the structure of some bright line spectra was undertaken in this laboratory. The most recent experiments of Aston (*Phil. Mag.*, May 1923, p. 934) have definitely established that tin is a highly complex element, being a mixture of eight isotopes of atomic weights 120, 118, 116, 124, 119, 117, 122 and 121, in which case the isotope displacement for 5631, for isotopes 120 and 124, and 120 and 116, is roughly equal to $\pm 0{\cdot}0007614$, that is, for 116 and 124, 0·001523; while according to McLennan's view it is equal to 0·03807 and 0·07614, which is well within the limits of resolution of an ordinary Lummer plate or Fabry Perot etalon. Therefore the structure of the lines 5631 and 4524 was carefully examined by a Lummer plate, the R.P. of which for 5631 = 250,000. In these experiments the arc was enclosed in a chamber surrounded by a water jacket, and the radiation from the arc was examined at different pressures. It was found that even when the pressure was low (that is, of the order of 1 mm.) both the lines were simple in structure, especially the line 4521, which was very sharp. These experiments do not, therefore, support the view put forward by McLennan.

A. L. NARAYAN.
M. R. College, Vizianagaram,
South India, September 11.

A Substitute for the McLeod Gauge.

ALTHOUGH numberless accounts have appeared of the precautions necessary in the obtaining of high vacua, some serious workers seem still to imagine that they can reach "a perfect vacuum" or "a pressure of 0·001 mm." in an apparatus from which absorbed water has not been removed. The lingering of this ancient superstition is due to the prevalence of the McLeod gauge; if any gauge which indicates vapours as well as permanent gases had been in general use, it could never have arisen. Historians may dispute whether the invention of the McLeod gauge has advanced or retarded the development of science; but there is no doubt that to-day, though it may have special uses (such as the calibration of other gauges) under rigidly controlled conditions, it is usually a mere relic of the past.

Compared with its adequate substitutes the McLeod gauge has not even the merit of convenience. In particular, although some workers who are perfectly aware of its limitations continue to make it a normal component of any pumping system, it is not the most

convenient gauge even for such a commonplace purpose as detecting leaks and ensuring generally that the system is in good order. We think we may be doing some service to our colleagues if we urge on them the advantages for this purpose of the Pirani gauge, especially if used according to the method that the staff of these laboratories described (but did not discover) in Physical Society Proceedings, vol. 33, p. 287, 1921.

The great advantage of this instrument is its magnificent simplicity. In addition to some very ordinary electrical gear—a battery, rheostat, 3 fixed resistance coils adjusted very roughly, a cheap pointer galvanometer, and a respectable voltmeter—it needs nothing but an ordinary incandescent vacuum lamp. Since lamps are cheap and since the same electrical gear will serve any number of lamps, there is no limit to the number of gauges which can be readily attached to the same piece of apparatus. The diagnosis of leaks and other faults is a very simple matter when gauges are attached at almost every joint, and their readings with the pump running are compared. But this is not its only virtue. We are certain that any one who tries the Pirani gauge will forthwith consign his McLeod gauge to the dust heap and wonder how he ever managed with such a cumbrous and misleading device.

It is sometimes objected to all gauges but the McLeod, that their calibration depends on the nature of the gas. To this we would reply that in every experiment we can imagine in which a knowledge of the *absolute* value of the pressure is required, either the nature of the gas is known or it has to be determined for some purpose other than that of reading the gauge.

As we have said, an ordinary incandescent lamp will do as a gauge; but it is even simpler (and for various reasons preferable) to use the same lamp before it is evacuated and with the pumping stem still attached. Probably any lamp maker would supply such lamps; if they are obtained from these laboratories, they will be furnished with a rough calibration—a calibration as good as that which the McLeod usually receives.

NORMAN R. CAMPBELL.
BERNARD P. DUDDING.
JOHN W. RYDE.

Research Laboratories of the
G.E.C., Ltd., Wembley.

Zoological Bibliography.

I AM desired by the Corresponding Societies' Committee of the British Association to direct attention to the Report of the Committee on Zoological Bibliography and Publications, which was presented at the Liverpool meeting of the Association, and to ask those interested in the publications of scientific societies earnestly to consider the recommendations made by this Committee, and thus avoid the unnecessary confusion and difficulties which arise from thoughtlessness rather than ignorance.

There are many important points to be borne in mind, particulars of which can be seen in the Report of the Committee, which can be obtained from the Secretary of the British Association, Burlington House, Piccadilly, W.1, but those to which particular attention is desired are: (1) The size of the publication, which should be demy-octavo (that is, the size of the Reports of the British Association); (2) that each part issued should bear the actual date of publication; and (3) that the titles of papers should, so far as possible, give a fair idea of the contents of the papers, and be brief.

T. SHEPPARD.

The Museums, Hull.

A New Method of Crystal Powder Analysis by X-rays.

FOR the purpose of enabling us to make more accurate comparative intensity measurements by the photographic powder method, and also of obtaining sharper lines without recurring to long exposures, an arrangement has been tried in which a thin layer of powder and a beam of greater angular width are used.

Modifications of the original arrangement of Debye and Scherrer and of Hull making use of wide beams have been described by H. Seemann, by H. Bohlin, by Sir William Bragg, and by the writer.[1] It has in particular been shown by Sir William Bragg, that by his arrangement, which involves the use of the ionisation method, it is possible to make not only rapid

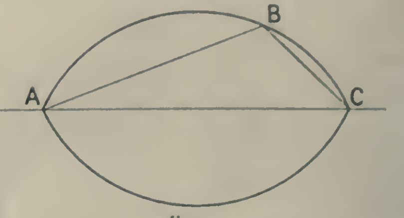

FIG. 1.

but also very accurate determinations. The present arrangement is intended to correspond to the peculiar conditions of the photographic record.

A short reference to the general conditions of reflection may take the place of an extended discussion. The geometrical locus of all crystal powder particles, which are so situated that rays reflected by them from A to C (Fig. 1) suffer the same deflexion α, is that surface of revolution described by the rotation of the arc of a circle ABC subtending the angle $\pi - \alpha$ on the chord AB. This surface has a different shape for each angle of deflexion α.

To obtain simple conditions for a quantitative interpretation of the reflected intensities the writer had used (*loc. cit.*) an equatorial annular band of this

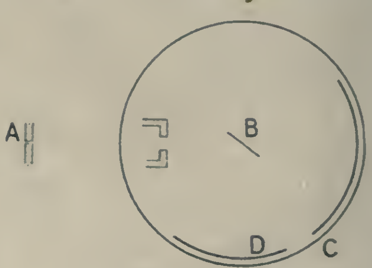

FIG. 2.

surface in conjunction with a point source of X-rays. At present in order to obtain lines which are more suitable for exact angular measurement, only a small area round B is used in connexion with a line source. The line source allows us to make more efficient use of the radiation of the anticathode and partly compensates for the decrease in angular extension of the beam.

Fig. 2 represents the arrangement adopted. A is the line source of X-rays situated close to the anticathode, B the powder layer, which can be rotated about an axis parallel to the source, and C is the film on which the lines are recorded. According to the geometrical relations given above, to every angle of deflexion, *i.e.* to every point on C, there is associated

[1] H. Seemann, *Ann. d. Phys.* 59, pp. 455-464, 1919; H. Bohlin, *Ann. d. Phys.* 61, p. 421, 1920; Sir William Bragg, Proc. Phys. Soc. 33, p. 222, 1921; J. Brentano, *Arch. Sc. Phys. et Nat.* (5) 1, p. 550, 1919.

a definite orientation of the powder layer at B, which corresponds to the orientation of the surface of revolution and vice versa. In order to record the lines over an extended angular region a screen D has therefore to be provided with an opening, which for any particular position of B uncovers only the corresponding portion of C. The screen has to be moved with uniform angular velocity and B has to take the corresponding required positions. If we call β_1 and β_2 the glancing angles of incidence and of emergence at B then $\frac{\sin\beta_1}{\sin\beta_2}=\frac{AB}{BC}$ and $\beta_1+\beta_2=\alpha$ is the angle of deviation. The relation between the motion of the screen and of the powder layer becomes the simple spectrometer relation when AB equals BC, but this arrangement is not the most efficient for obtaining beams of greatest specific intensity. With the setting corresponding to a given resolving power the time of exposure will depend on the angular width of the region explored. The method is most efficient for exploring small angular regions for the exact measurement of a few characteristic "key" lines, but owing to the gain in intensity by using wide beams there is some saving of exposure also for more extended surveys.

A fuller discussion of the method and description of the apparatus used will be given elsewhere. With a small camera of this type, BC being 2·3 cm., a photograph was taken of the first order reflection of CuK radiation from the 111 and 100 faces of nickel oxide with 1·2 milliamp-hour exposure, the angular extension of the region recorded being about 20°. The lines were less than 0·1 mm. wide and their centres could be evaluated to 0·03 mm. When the greatest possible intensity is required for tracing faint lines in a narrow angular region, a powder layer of suitable curvature which allows us to use beams of considerable angular width is of advantage. For quantitative measurements, where the absorption under different angles of incidence has to be taken into account, and for exploring wider angular regions, a flat surface is more suitable. By exposing it from different sides, errors due to eccentricity in mounting can then be eliminated. This procedure was used in the case of the nickel oxide mentioned. J. BRENTANO.

The Physical Laboratories,
The University, Manchester,
October 12.

A Large Sarsen Stone.

A SARSEN stone of unusual size, for this district, has recently been found in the gravel pit belonging to the Hounslow Sand and Gravel Co., and through the courtesy of the manager, Mr. Ralph Wallis, I have been permitted to pay several visits for purposes of investigation and photography.

In section, the pit shows:

Soil	1 ft.
Indurated mud, like warp .	1 ft. 6 in.
Loamy gravel, penetrated by the warp (averages) . .	7 ft.
"Clean" gravel and sand .	8 to 21 ft.

resting on London Clay of unknown thickness.

The sarsen (Fig. 1) was found embedded to the depth of 1 ft. in the London Clay with several others of much smaller size—from a few lb. to about 2 cwt.—and they were the only ones found there. It is computed to weigh 6 or 7 tons, but owing to the number of tubular cavities present, varying in length from a few inches to 3 ft., and in diameter from $\frac{1}{16}$ to 2 in., even an approximate computation may have to be considerably revised. Its maximum height, as now standing, is 5 ft. 7 in., maximum thickness 1 ft. 11 in., and its maximum width 5 ft. 7 in.

There are several interesting details which might occupy too much space to describe here, but perhaps I may be permitted to refer to the cruciform surface-feature conspicuous in the photograph of the surface which was uppermost when the block was *in situ*. It is due to the fact that two of the long, tubular cavities cross each other in the heart of the stone, this being rendered visible through the erosive action of falling

FIG. 1.—Sarsen stone from London Clay.

water, at some time or another, forming a basin-shaped depression, 4 ft. in diameter and 7 in. deep, which has exposed the internal structure. There is little doubt but that the tubular cavities have also been considerably enlarged and modified by the action of running water. A few striations on one of the faces strengthen the assumption of its association with ice-action. The rock is of the usual type—a very hard siliceous sandstone, white within and stained externally by contact with ferruginous water.

C. CARUS-WILSON.

October 10.

Dr. Kammerer's Ciona Experiments.

IN NATURE of May 12, p. 639, Dr. Kammerer wrote: "Not content with any of the previous experiments [made by himself on the inheritance of acquired characters], I carried out, before 1914, what may really be an *experimentum crucis*," and Dr. Kammerer states that when the siphons of *Ciona intestinalis* are cut off they regenerate longer than they previously were, repeated amputations giving very long tubes, and that the offspring of these individuals have siphons longer than usual.

I repeated these amputation experiments between June and September last at the Roscoff Biological Station. The oral siphon was removed from 102 *Ciona intestinalis* which were growing attached to the walls of the tanks. The animals varied in length from 0·9 to 4·8 cm. As controls, 235 unoperated individuals were kept under observation. In none of the operated animals was there any further growth of the siphons after the original length had been re-attained.

One operation was performed on 59 individuals, two on 35, and three on 8. The time necessary for

the re-attainment of the original siphon-length depended on the level at which the cut had been made: it varied from 14 to 44 days, with an average of 27 days. The animals operated upon once were kept under observation from 22 to 61 days after the original siphon-length had been re-attained, the average period being 42 days; those operated twice for an average of 34 days; and those three times for 27 days after the last re-attainment of the original siphon-length. In none of the operated animals did any further growth of the siphons take place after the original dimensions had been reached.

After this negative result of the preliminary experiment it seemed useless to try Dr. Kammerer's further operation of removing the gonads from the animals with re-grown siphons, allowing other gonads to regenerate, and then breeding a second generation.

In 1913 it was shown at Naples that abnormally long siphons of *Ciona intestinalis* can be grown by keeping the animals in suspensions of abundant food (*Biol. Centrbl.* 1914, vol. 34, p. 429). Were this the reason for the long siphons of Dr. Kammerer's operated *Ciona*, it should have been clear from controls of unoperated animals kept in the same water.

A full account of the work at Roscoff will shortly be published in the *Journal of Genetics*.

H. MUNRO FOX.

Zoological Department, Cambridge.
October 16.

Selective Interruption of Molecular Movements.

I WAS somewhat surprised to see that in spite of Mr. Atkinson's letter, Mr. Fairbourne, in NATURE of July 21, still endeavours to maintain his view that the relative gas-pressure in two communicating vessels at equal temperature depends upon the shape of the channel joining them, provided the pressure is sufficiently low. The proper method of treating the question, which of course does not lead to such an extraordinary result, may be found in any text-book on the kinetic theory, and it might have been expected that Mr. Fairbourne, before claiming to prove a paradox of this sort, would indicate in what way the usual treatment is wrong. Instead of doing so he adopts a curious treatment of his own, in which he shows that in certain circumstances more paths lead into one vessel than into the other, without considering that the number of molecules which enter either vessel in unit time depends not only upon the number of such paths but also upon their length. When this is taken into account the usual result is obtained, namely, that the pressure in the two vessels is equal whatever the shape of the channel between them.

F. A. LINDEMANN.

Clarendon Laboratory, Oxford,
October 15.

Effects of Anæsthetics on Plants.

ANÆSTHETICS are known to cause alterations in the permeability of cells to the ions of various salts. It can be shown directly, by using the corolla of *Ipomœa Learii*, that the permeability of plant cells to carbon dioxide is also altered by anæsthetics.

The corolla consists of two layers of cells only, with thin cuticle, no intercellular spaces, no stomata. The cell-sap contains an anthocyanin, which indicates P_H (thus avoiding complications due to an added indicator). The buds are pink (P_H 6), changing to full blue (P_H 7·8) as the flower opens, in 30-40 minutes. The blue changes through violet to pink as the flower withers (6-8 hours). Portions of the blue corolla floated on water saturated with carbon dioxide rapidly turn pink: this change is reversible on removing to plain water.

If discs cut from the corolla are first treated with aqueous solutions (0·04M-0·1M) of chloroform or ether, and then with a saturated solution of carbon dioxide (P_H 5), a time-curve can be constructed, showing the changes in permeability to carbon dioxide induced by varying exposures to the anæsthetics.

The first effect is a marked decrease (often as much as 50 per cent.) in the rate of penetration of carbon dioxide into the cell, the decrease lasting 10-15 minutes; the rate then increases rapidly, reaching 200 per cent. in 40 minutes, and continuing to increase. After 40-50 minutes' exposure to the anæsthetics the tissue becomes irresponsive.

In order to reach the cell-sap the carbon dioxide must pass through (1) the cell-wall, (2) the protoplasm lining the cell-wall. The fact that the cells of the disc change colour simultaneously shows that the carbon dioxide passes freely through the wall. On the other hand, hydrochloric, sulphuric, and acetic acids of the same P_H as the carbonic (P_H 5) penetrate only from the cut edges of the discs inwards, and not over the whole area. The addition of ether or chloroform to these acids has a similar effect on their rate of penetration into the cell as on carbonic acid. It is therefore concluded that ether and chloroform alter the permeability of the plant cell to carbon dioxide by their action on the protoplasm and not on the cell-wall.

These alterations in permeability to carbon dioxide may affect the *apparent* rate of respiration (measured as carbon dioxide output) under anæsthetics, and a suitable correction may require to be made in such experiments.

E. PHILIP SMITH.

46 Murrayfield Avenue, Edinburgh,
October 13.

Stereoisomerism among Derivatives of Diphenyl.

THE references to Dewar's formula for benzene which are made in the letters of Dr. Turner and Dr. Kenner in NATURE of September 22 and October 13 (pp. 439 and 539) raise a point of some importance in regard to the use of symbols in chemistry. Sir William Bragg's work has revealed the fact that the length of the carbon-to-carbon bond is remarkably constant at about 1·5 Å.U. Dr. Turner, however, following the common convention, represents the para-linkage in his formula for diphenyl by a bond which is perhaps twice as long as those joining adjacent atoms in the ring. It is, of course, possible to maintain the normal length of the bond by distorting the benzene hexagon into a quadrilateral, thus,

```
    H
HC—C—CH
 ‖  |  ‖  ;
HC—C—CH
    H
```

but there is, I believe, no indication whatever of any such extreme distortion in Bragg's work on the X-ray analysis of crystals of aromatic compounds. This difficulty would not arise if the para-linkage were regarded as indicating only the existence of "free affinities" on the 1 and 4 carbon atoms, or of an electrovalency between them; but so long as this link is treated as a real bond, there does not seem to be any justification for stretching it to an abnormal length, although this is clearly necessary in order to preserve the very well founded idea that the benzene-ring is fundamentally hexagonal in form.

T. M. LOWRY.

The University, Cambridge,
October 18.

The Origin of Optical Spectra.

AMONG the many remarkable communications made this year to Section A (Mathematics and Physics) of the British Association, which, grouped together, will probably mark it off as an outstanding meeting, the address by the sectional president, Prof. McLennan, on the origin of spectra, was not the least interesting. From among the many subjects he surveyed it may be of interest to select some, and to try to give a not too technical account of these, showing the sort of progress that is now being made under the stimulus of Prof. Bohr's theory.

We agree now that all spectra are emitted by atoms or molecules during the process of return to their normal state after a more or less violent disturbance, and that any particular spectrum is emitted only by a particular atom or molecule after a suitable disturbance. We agree too (partly for theoretical, partly for experimental reasons) that spectra can be divided into two distinct types—line spectra or series spectra and band spectra or many-line spectra—which have their origin in the reconstruction of atoms and molecules respectively. It is with recent advances in the more advanced and more important study of these atomic or line or series spectra, emitted during the reconstruction of atoms, that the president dealt, and with these only shall we be concerned here.

Physicists will agree that an atom consists of a very small massive nucleus of positive electric charge Z units, the unit being the charge on the electron, surrounded by a planetary system of Z electrons. These move, when undisturbed, as a conservative system in a set of orbits which must have a definite structure, controlled by laws of which we are not yet masters, to which, however, the present quantum theory gives the most complete expression yet achieved. The number Z is called the atomic number of the atom, and specifies its place in the periodic table and all its physical and chemical properties. We can agree further that the orbits of the Z electrons are not all essentially different. They can be classified in groups, orbits of which are characterised by the same values of certain integers (three to each orbit), commonly called quantum numbers.

There are a variety of disturbances to which such an atom can be subjected. By suitable means supplying sufficient energy we can shift one or more of its electrons from their normal orbits, either right out of the atom, or into other possible orbits characterised by different quantum numbers. In the subsequent reconstruction the atom will emit a spectrum of sharp lines of definite frequencies characteristic of itself and the particular disturbance it has suffered. Each separate line is emitted during the return of an electron from one particular permissible orbit to another of less energy, and its frequency is related to these orbital energies by the most fundamental equation of the quantum theory $E_1 - E_2 = h\nu$. After the partial removal of a particular electron we merely get part of the spectrum corresponding to complete removal of the same electron. We can therefore, speaking generally, classify the complete line spectrum of a given atom into a number of separate spectra, each of which is associated with the recapture of one electron by an atom after the removal of any specified set of its original Z electrons. Classified thus, an atom's spectra will divide into two well-marked types—those in which one or more of its deeper lying electrons have been removed and those in which the electrons removed, whatever their number, are entirely those most lightly bound. In the first type we can and do find internal reorganisations taking place before a new electron is captured. These are the X-ray spectra, with which we are not here concerned. In the second type no such reconstruction can occur, except while the new electron is being brought in. These spectra, which theoretically must all be of the same general series type, are called the optical spectra of the atom.

The typical optical spectrum (the so-called arc spectrum) of an atom is agreed to be that which is emitted during the return of the last (Zth) electron to an atom in which the rest of the system is in its normal state. When such a spectrum is fully analysed it is found that the lines can be arranged in series which display a certain fundamental constant R, Rydberg's constant. The value of this constant and its perpetual occurrence in all arc spectra is (as is well known) properly predicted by the theory. But this is not all. If we call the ordinary arc spectrum Z(I) and its Rydberg's constant R, the theory we have outlined predicts Z optical spectra in all, of which the Qth spectrum Z(Q), with constant Q^2R, will be emitted by the atom with its first $(Z-Q)$ electrons in their proper orbits as it catches its $(Z-Q+1)$th electron. The characteristic *frequencies* of these spectra will, of course, get higher and higher as Q increases, and for the later "optical" spectra of a heavy element will lie in the X-ray region. It is not the frequency range but the *type* of spectrum which remains characteristically optical.

The predicted second optical spectra Z(II), with Rydberg constant 4R, have been known for some years for a number of elements, under the general name of spark spectra; until recently we have had no experimental confirmation for values of Q greater than 2. In the last year there has been a great advance, for the third optical spectrum of aluminium with constant 9R has been obtained by Prof. Paschen, and the fourth and parts of the third optical spectra of silicon with constants 16R and 9R respectively by Prof. Fowler. These spectra are known by the very convenient notation of Al III, Si IV and Si III. It will be seen that the spectra Si IV, Al III, Mg II and Na I are all concerned with the capture of the eleventh electron by an atom (of varying Z) which has already bound its first ten electrons in their permanent orbits. These four spectra should be and are of the greatest similarity in their finer details. Their further detailed comparative study should be fruitful.

Prof. McLennan also pointed out that this successful study should throw light on the various optical spectra of the analogous series of elements, lithium, beryllium, boron, and carbon. In this difficult and very important region little progress has hitherto been made, but Prof. McLennan seemed hopeful that, with the theoretical and comparative guides now available, a renewed

attack would be successful in completing and classifying these spectra.

These are the broad outlines; let us now turn to finer details. It is well known that the theory, though it gives us general information about all optical spectra, so far can only predict in all its finer details the spectrum due to the binding of the first electron. The only spectra of this type yet experimentally realised are what we may now call H I and He II, that is, the spectrum of atomic hydrogen of which the most conspicuous feature is the well-known Balmer Series, and the spectrum of ionised helium. Now the predictions of the theory not only give the exact position of each line, but, as is well known, also assign to each line a definite complex structure. Under very high dispersion and first-class conditions this structure can be observed. In the case of He II, where the separations are greater and the conditions less severe, the confirmation of the theory was completed some years ago by the photographs of Prof. Paschen and others. Until recently, however, the similar more difficult experiments for the Balmer Series have been inconclusive and discordant. For this series the theory demands that each line should split into two close lines of the same frequency difference, which should themselves have a still finer detailed structure. Into this we need not enter, beyond saying that this ultimate structure should slightly reduce the apparent separation of the lines of longest wave-length, particularly H_α. Now the last lacuna has been filled by a brilliant piece of work in Prof. McLennan's laboratory, for good photographs have been obtained showing clearly the main separations of the five lines of longest wave-length. The agreement with the theory is complete. To illustrate the fineness of the detail it may be mentioned for example that for the fourth line H_δ, wave-length $4101 \cdot 73 \times 10^{-8}$ cm., the theoretical main separation is only $6 \cdot 1 \times 10^{-10}$ cm.

It has been known for some time that the energy required to remove one electron from neutral helium was (in the usual terminology) about 25 volts. We thus express the energy acquired by an electron in falling freely through such a potential difference. Thus expressed the energy required to remove the most lightly bound electron is known as the ionisation potential. Until recently the known part of the spectrum He I made no allowance for a normal atom in which the electrons were so firmly held. It appeared that these ought to be a series of lines in the far ultra-violet, not hitherto observed, associated with the reconstruction of the normal atom. Four such lines have now been observed by Lyman. The wave-lengths are very short, from 500 to 600×10^{-8} cm., and indicate an ionisation potential of $24 \cdot 5$ volts, in good agreement with direct observation. Our experimental knowledge of He I is thus properly rounded off. Much valuable work on the theory of this spectrum has also been completed, but the results are negative. It is now certain that none of the models so far proposed possess the proper permissible orbits, computed according to the rules of the present quantum theory, to account for the spectrum He I and the ionisation potential. It is an advance to be sure of this. The interaction of the two electrons in helium (and *a fortiori* the Z electrons in the general atom) must be even more subtle, and the *detailed* theory of their orbits must lie even deeper, than has been hoped hitherto.

Recent work has shown the very great value of the study of the absorption spectra of atomic vapours in the coldest state in which they can be procured at reasonable densities. Such vapours, as is well known, absorb selectively a number of sharp lines which are a selection of the lines of the first optical (emission) spectrum. But since the atoms of the vapour must in general be in their normal state, only those lines can appear which belong to atomic reconstructions ending in this normal state. We can thus select from the whole mass of lines just those associated with one particular state of the atom, and that the most important. In this way certain difficulties have been cleared up in connexion with the spectrum Al I and its analogues. It had been believed that the normal orbit of the most lightly bound electron was of the same type for all atoms—that is, specified by a certain value (unity) of one of its quantum numbers. This is the theoretical interpretation of the empirical belief that the absorption spectrum would always consist of the same type of series. But the known facts about this group of spectra did not fit in with this belief, and it is now definitely established by the study of absorption spectra that this belief is false. The normal orbit in question may have at any rate one or two for the value of this quantum number, and has the value two for aluminium and its analogues. Thanks to this we now know that our account of these spectra is reasonably complete. The study of absorption spectra will doubtless prove of great value in disentangling the difficult spectra of the lead-tin group. A good start has recently been made in their classification.

Let us with Prof. McLennan conclude by referring to the effect of an applied magnetic field on the atomic orbits, with which is bound up the question of the way in which the atom orientates itself in space under such an influence. The effect on the spectrum is known as the Zeeman effect, and its study is proving of the utmost importance to the theory of atomic structure. It is here that we shall probably win the next advance. We can scarcely expound these questions shortly and cannot enter into details here. But it may be said that the proper classification of the empirical facts, largely the work of Prof. Lande, seems already fairly complete, and that their theoretical interpretation has been begun on a sure basis. We must not, however, omit to mention the cognate beautiful experiment of Stern and Gerlach, which consists in directing atoms of silver of known velocity through a strong non-uniform magnetic field. If the atom possesses a magnetic moment it must be deflected, unless its axis is always perpendicular to the field. Such deflexions were observed, and appear to prove, simply and directly, that the normal free atom of silver possesses a definite magnetic moment and always sets itself with its magnetic axis parallel or anti-parallel to the field. Experiments such as these are of the greatest importance. They admit of unambiguous interpretations and provide the necessary strong points from which the attack on the complicated Zeeman effect and related phenomena can be securely launched.

R. H. FOWLER.

Symbiosis in Animals and Plants.[1]

By Dr. GEORGE H. F. NUTTALL, F.R.S., Quick Professor and Director of the Molteno Institute for Research in Parasitology, University of Cambridge.

I. SYMBIOSIS IN PLANTS.

(1) *Lichens.*

IT is well known to botanists that the vegetative body (thallus) of lichen plants consists of two distinct organisms, a fungus and an alga ("gonidia"). Schwendener (1867–69) regarded the fungus as living parasitically upon the alga, a view which gained support from subsequent researches, especially those of Bonnier (1886–9), wherein synthetic cultures were obtained by bringing together (*a*) various algæ and (*b*) fungus-spores isolated from cultures of fungi forming the one component of certain lichens.

The long and apparently healthy life of the associated fungi and algæ led de Bary (1879) to define the condition as one of *symbiosis*, the term denoting *a condition of conjoint life that is more or less beneficial to the associated organisms or symbionts.*[2]

Investigation has shown that the relation or balance between the associated organisms varies in different lichens; in some the partners inflict no injury upon each other; in some, occasional parasitism of the fungus upon the alga is observable. Elenkin (1902–6) and Danilov (1910) take it as proved that lichens owe their origin to parasitism, the fungus either preying upon the alga or living as an "endosaprophyte" upon the algæ that die.

Therefore we may find in lichens the condition of true symbiosis on one hand, ranging to demonstrable parasitism on the other, and, conversely to what has been described above, examples are known wherein algæ are parasitic on fungi (Beijerinck, 1890).

The nutrition of algæ in lichens is similar to that of other chlorophyllaceous plants, the most important work on the subject being that associated with the names of Beijerinck (1890) and Artari (1902). The algæ associated with fungi in lichens are placed advantageously in respect to nitrogen supply. The important researches of Chodat (1913) have demonstrated that cultivated gonidia develop four times as well when supplied with glycocoll or peptone in place of potassium nitrate.

The gonidia lead a more or less saprophytic life in that they obtain from the fungus-hyphæ both organic nitrogen and carbon in the form of glucose or galactose. The nutrition of fungi in lichens depends partly upon parasitism, when they invade the gonidia, and partly upon saprophytism, when they utilise dead gonidia (Chodat). M. and Mme. Moreau (1921) regard the fungal portion as a gall-structure arising from the action of the associated alga. The lichen, according to this view, is to be regarded as a fungus that has been attacked by a chronic disease which has become generalised and necessary for the subsistence of the host-fungus.

[1] From the presidential address delivered to Section I. (Physiology) of the British Association at Liverpool on September 13.

[2] Bacteriologists are continuously misapplying the term symbiosis in referring to bacteria grown in mixed cultures, when there is no evidence whatever that the micro-organisms are mutually interdependent for their growth.

(2) *Root-nodules.*

A well-known example of symbiosis is afforded by the presence of the bacteroids in the nodules of Leguminosæ, the micro-organisms being capable of fixing atmospheric nitrogen and thereby rendering nitrogen available for assimilation by the plant. Nodules on the roots of the alder are attributed to the presence therein of Streptothrices, and comparable nodules occur in Eleagnaceæ. The nodules on the leaves of Rubiaceæ and tropical Myrsinaceæ are also regarded as due to bacterial symbionts.

(3) *The Significance of Mycorhiza in Relation to Various Plants.*

The roots of *most perennial and arborescent plants* are invaded by the mycelium of fungi known as Mycorhiza, and according to hypothesis we are here dealing with symbiotic life. Frank distinguishes two forms of Mycorhiza: (1) the ectotrophic, which surround the root externally (found especially about the roots of forest trees), and (2) the endotrophic, which penetrate deeply into the root tissue and its cells. The fungus utilises the reserve substances stored in the cell. The intracellular mycelial mass after a time undergoes degeneration, is digested by the host, and the host-cell resumes its normal life. Further details regarding these fungi will be found in the paper of Gallaud (1904).

Mycorhiza in Orchids.—The first to note the presence and to attempt to cultivate the fungus mycelium in the roots of orchids was Reisseck (1846), and in 1881 Kamienski advanced the hypothesis that the association was one of symbiosis. Wahrlich (1889) subsequently found symbionts in all species of orchids he examined, about 500 in number, thereby showing that their distribution is generalised. It is to the researches of Noël Bernard (1902 onward), however, that we are actually indebted for the complete demonstration of the true relation existing between orchids and Mycorhiza, based as it is upon physiological studies.

The essential discovery of Bernard was that orchid seeds do not germinate in the absence of fungi belonging to the genus Rhizoctonia. Each species of orchid, according to the subsequent researches of Burgeff (1909), possesses a special species, variety, or race of fungus that is particularly adapted to it—he distinguishes fifteen species of fungus. The fungus mycelium, having attained the parenchyma cells, develops into characteristic filamentous masses recalling the appearance seen in bacterial agglutination. After a time, the development of the fungus is arrested by the deeper parenchyma cells of the seeds. These digest the mycelium, but the cell continues to harbour remains of the fungus ("corps de dégénérescence") which occur abundantly in the tissues of orchids. The seed now proceeds to sprout, giving rise to a small tubercle, which at a later period produces leaves and roots. The cultivation of Rhizoctonia of various species was carried out successfully by Bernard, the cultures being used to reproduce germination in orchids.

The relation between the fungi and orchids varies in different groups of these plants. In some cases symbiosis is intermittent, in others continuous. In *Neottia nidus-avis* the symbiotic condition is maintained throughout the life-cycle of the orchid, the fungus being found in the roots, rhizome, and even in the flowers and seeds, and it is transmitted hereditarily.

The Origin of Tubers in Various Plants.—The occurrence of endotrophic Mycorhiza in the roots of species of Solanum has been recorded by various observers. Experimenting with the potato, Molliard (1907, 1920) found that tubers were not formed in aseptic cultures. Magrou (1921) placed potato seeds in a poor soil and close to *S. dulca-mara*, which always contains fungi, and found that only when the fungus invaded the potato plant were tubers formed.

Magrou also investigated tuberisation in *Orobus tuberosus* (Leguminosæ) and in *Mercurialis perennis* (Euphorbiaceæ), and from his collective studies concludes that—

(1) When the potato plant and Orobus are raised from seed, the establishment of symbiosis leads to tuberisation of the sprouts at the base of the stem; tubers are not formed in the absence of symbionts. (2) Owing to developmental differences between the two plants, symbiosis in the potato plant is intermittent, whilst in Orobus it is continuous. (3) It follows that these plants may develop in two ways: (*a*) when they harbour symbionts they produce perennial organs; (*b*) without symbionts they are devoid of perennial organs. (4) It is the rule for wild perennials to harbour symbionts, as Bernard has stated, whilst annuals are devoid of symbionts; three species of annuals (*Solanum nigrum, Orobus cœcineus*, and *Mercurialis annua*) may be penetrated by endophytes, but they quickly digest the intruders. (5) These observations confirm and supplement the view held by Bernard that tuberisation is due to the association of fungi with plants.

Mycorhiza in Ericaceæ, Club-mosses and Ferns.—Rayner (1915–16) finds that Mycorhiza are constantly present in heathers. He isolated Mycorhiza (of the genus Phoma) from *Calluna vulgaris*, in which the fungus is widely distributed, being found in the roots, branches, and even in the carpels, so that it occurs within the ripe fruit and seed tegument. Calluna seeds, when grown aseptically, give rise to poor little plants devoid of roots, but, under like conditions, in contact with Phoma the plants develop normally and form many roots.

In Lycopodiaceæ (Club-mosses) and Ophioglossaceæ (Ferns), according to Bernard, the perennial prothallus is infested, and the spores whence the plants emanate will not germinate except (as with orchid seeds) with the help of fungi.

The foregoing emphasises the significance of symbiosis in the vegetable kingdom. I will close by mentioning the theoretical deduction of Bernard that vascular plants owe their origin in the past to the adaptation of certain mosses to symbiotic life with fungi.

II. SYMBIOSIS IN ANIMALS.

(1) *Algæ as Symbionts.*

Animals of widely separated groups characterised by their green colour have long been known. Already in 1849, von Siebold attributed the colour of *Hydra viridis* to chlorophyll, which, for a period, was regarded as an animal product. In 1876, Gésa Entz concluded that the chlorophyll is contained in vegetable cells living as parasites or commensals within the animals; these cells were aptly named *zoochlorella* by Brandt (1881), whilst cells distinguished by their yellow colour were subsequently called *zooxanthella*, the latter having been first described by Cienkovsky (1871) as present in Radiolaria. Zoochlorella occur mainly in fresh-water animals; zooxanthella mainly in marine animals; the symbionts, measuring 3-10 microns in size, being found in many Protozoa, Sponges, Cœlenterates, Ctenophores, Turbellaria, Rotifers, Bryozoa, Annelids, and Molluscs.

Physiological studies upon the relations between animals and symbiotic algæ have yielded interesting results in Protozoa, Cœlenterates, and Turbellaria.

Symbiotic algæ are not usually transmitted hereditarily, each host-generation being usually infected afresh by algæ. Where Protozoa multiply by division the algæ pass directly to succeeding generations. Hereditary transmission occurs in hosts that undergo sexual multiplication (as in *Hydra viridis*). From the circumstance that in most cases symbiotic algæ are not transmitted hereditarily, we may explain the occasional occurrence of alga-free individuals in a species usually harbouring the symbionts.

Studies conducted on Turbellaria are of special interest. The best-known example of symbiosis in Turbellaria is found in *Convoluta roscoffensis*, a species that has been well studied by Keeble and Gamble (1903–7). Its larvæ are colourless, and infection occurs after hatching. The cocoon, on the day following its deposition, is already invaded by algæ.

In *Vortex viridis* symbiosis is not necessary; in Convoluta it is necessary for both partners. Mature Convoluta are never found devoid of algæ in Nature. The young larva can only feed itself for a week; as it grows older it becomes infected progressively with algæ. There are four periods in the life of Convoluta, wherein the animal lives at the expense (1) of formed substances, (2) of these and alga-products, (3) of alga-products only, and finally (4) of the algæ themselves. This constitutes a true evolution in a species from a free existence, depending only on outside sources of food supply, to a symbiotic mode of life, and lastly one merging into parasitism.

(2) *Symbiosis in Insects.*

Among insects we find a whole series of progressive adaptations toward an association with micro-organisms of different categories:

Group I.—*The utilisation by insects of micro-organisms cultivated by them outside their bodies.* To quote three examples: (1) The larvæ of the beetle *Xyloteres lineatus* (Bostrichidæ) form galleries in the wood of pines in which the fungus Ambrosia is cultivated by the larva for food. The beetle is incapable of digesting cellulose. (2) *Termes perrieri* of Madagascar builds chambers and galleries. The termites collect dead wood, chew it up finely, swallow it, the wood passing unaffected through their intestine and out in the form of small spherical masses (0·5 mm.) which are cemented together as porous cakes. Fungi which

develop upon the cakes serve as food for the termites. (3) Ants belonging to the genus Atta cultivate fungi; the queen, when about to found a new colony, carrying away a small ball of fungus wherewith to start a fresh culture in the new habitat.

Group II.—*Symbiotic organisms developing in the lumen of the intestine and its adnexa.* As examples may be cited the bacteria occurring in the intestines of fly larvæ (Musca, Calliphora, etc.), which aid the larva to digest meat; the bacteria associated with the olive-fly (*Dacus olea*); the Trychonymphids of xylophagous Termites (*Leucotermes lucifugus*).

Group III.—*Intestinal symbionts situated in the epithelial cells of the digestive apparatus.* In *Anobium paniceum*, a small beetle commonly occurring in flour, a part of its mid-gut contains cells filled with symbiotic yeasts undergoing multiplication. The symbionts are acquired by the larva on hatching, being eliminated by the female beetle.

Group IV.—*Intracellular symbionts of deep tissues.* This group of symbionts is most frequently found in insects, but their nature was not disclosed until recent years. Thus an organ, constantly present close to the ovary in Aphis, the "pseudovitellus," is now known to contain symbionts, for in 1910 Pierantoni and Šulç independently demonstrated that certain intracellular inclusions were yeasts the evolution of which they followed. Their results have been confirmed by various authors, especially by Buchner, to whose collective work on the subject most of our information regarding this class of symbionts is due.

Among the symbionts of deep tissues in insects are found a whole series of specialisations among the host-elements harbouring the symbionts. In Lecaniinæ yeasts are distributed throughout the body (perivisceral fluid, cells of fat-body); the fat-body cells may be regarded here as facultative Mycetocytes. In *Orthezia*, symbiotic bacteria occur in certain fat cells. In Cicadas, yeasts occur in fat cells which continue to accumulate fat, glycogen, and urates. In Blattids, symbiotic bacteria are found in special cells forming well-differentiated Mycetocytes. These also occur about the digestive tract of Pediculidæ (Hæmatopinus) and certain ants (Camponotus). Mycetocytes may agglomerate to form true organs termed Mycetomas, the component mycetocytes containing either yeasts or bacteria as symbionts, as in Aphids, Chermids, and Aleurodids. In Pediculus and Phthirus, parasitic on man, the mycetoma is disc-shaped and lies centrally as a distinct milk-white structure upon and indenting the mid-gut.

The mode of transmission of intracellular symbionts of insects from generation to generation may take place in different ways as defined by Buchner (1921, somewhat modified): I. The larva of each generation infects itself through the mouth (Anobiidæ). II. Infection takes place hereditarily through the egg. III. Embryonal infection as in parthenogenetic Aphids.

As already indicated, the symbionts may be yeasts, saccharomycetes, bacteria, or even nitrobacteria. Their entrance into the cells and their presence therein even in large numbers does not in many cases prevent multiplication of the invaded cells or affect their mitosis.

We know little regarding the part played by symbionts in insects; our information relates almost exclusively to their morphology, mode of multiplication, and entry into the host during its development. There are no indications that the symbionts are injurious or pathogenic. We may well ask ourselves what are the reciprocal advantages of this association, but this is a question that it is impossible to answer in view of our ignorance of physiological and biochemical processes in insects.

(3) *Micro-organisms in Relation to Luminescence in Animals.*

A fairly large number of organisms are known which have the faculty of emitting light. They are found among bacteria, fungi, protozoa, cœlenterates, echinoderms, worms, molluscs, crustacea, insecta, tunicata, and fish. As a rule, luminescence in animals depends upon the action of luciferase on luciferin, but recently a number of cases have become known wherein light production has been traced to micro-organisms, and it is with these cases that we shall deal.

Luminescent pathogenic bacteria may invade the host, as described by Giard and Billet (1889–90) for the small marine amphipod, Talitrus.

Luminescent symbiotic bacteria are present in luminescent organs of certain insects, cephalopods, tunicates, and fishes:—

Insects: Pierantoni (1914) found them in glow-worms (Lampyrus), the luminescent cells being crowded with minute bodies having bacteria-like staining reactions, these bodies being also present in the beetle's egg, which is luminous.

Cephalopods: We owe to Pierantoni (1917–20) and Buchner the discovery that luminescence in certain Cephalopods is due to light-producing bacterial symbionts living in special organs of the host. In Loligo the luminous organs, known as "accessory nidamentary glands," consist of epithelial tubes surrounded by connective tissue. In cuttle-fish (Sepiola and Rondeletia) the organs are more complicated, the glands being backed by a reflector, and provided outwardly with a lens serving for the projection of the light rays generated by the symbionts within the tubes. The symbionts are transmitted hereditarily when the Cephalopods lay their eggs. The symbionts of Loligo and Sepiola have been cultivated.

Tunicata: In Pyrosomidæ each individual in the colony possesses two luminescent organs, in which Buchner (1914) demonstrated symbiotic fungi that are transmitted hereditarily.

Fish: Of great interest are the researches of Harvey (1922) upon light production by two species of fish (Photoblepharon and Anomalops). Their luminescent organs are composed of a great number of sets of parallel gland tubes. Luminous material fills the lumen of the tubes and consists of an emulsion containing many granules and rods; the latter move about with a corkscrew-like motion, and are undoubtedly bacteria. The luminosity of the organ is due to these symbiotic bacteria.

In concluding this section dealing with light production by animals it may be repeated that we have to distinguish between (*a*) luminescence due to symbiotic organisms, such luminescence being continuous in the presence of oxygen as in cultures of luminous bacteria

(of which some thirty species are known), and (*b*) that due to animal cell-products known as luciferin and luciferase which are secreted and expelled *at intervals*, in response to a stimulus, from two kinds of gland cells, the secretions, when mixed, producing light.

Portier's Hypothesis.

The numerous cases in which symbiosis occurs in Nature have naturally led some biologists to ask if symbiosis is not a phenomenon of general significance, and perhaps essential, in living organisms. In this connexion reference must be made to the hypothesis advanced by Portier (1918), because it formulates extreme views. On faulty premises he built up an hypothesis that may be likened to a house of cards. He divides living organisms into two groups, autotrophic (bacteria only) and heterotrophic (all plants and animals), according as they are provided or not with symbionts. According to Portier, the mitochondria that are present in all plant and animal cells are symbionts. Space precludes further consideration of the subject here.

Conclusion.

The term "symbiosis" denotes a condition of conjoint life existing between different organisms that in a varying degree are benefited by the partnership. The term "symbiont," strictly speaking, applies equally to the partners; it has, however, come to be used also in a restricted sense as meaning the microscopic member or members of the partnership in contradistinction to the physically larger partners, which are conveniently termed the "hosts" in conformity with parasitological usage.

The condition of life defined as symbiosis may be regarded as balancing between two extremes—complete immunity and deadly infective disease. A condition of perfect symbiosis or balance is realised with comparative rarity because of the many difficulties of its establishment in organisms that are either capable of living independently or are incapable of resisting the invasion of organisms imperfectly adapted to communal life. In these respects the conclusions of Bernard and Magrou in relation to plants apply equally to animals. It is difficult to imagine that symbiosis originated otherwise than through a preliminary stage of parasitism on the part of one or other of the associated organisms, the conflict between them in the course of time ending in mutual adaptation. It is, indeed, probable that some supposed symbionts may prove to be parasites on further investigation.

In perfect symbiosis the associated organisms are completely adapted to a life in common. In parasitism the degree of adaptation varies greatly; it may approach symbiotic conditions on one hand, or range to vanishing point on the other by leading to the death of the organism that is invaded by a highly pathogenic animal or vegetable disease agent. There is no definite boundary between symbiosis and parasitism. The factors governing immunity from symbionts or parasites are essentially the same.

No final conclusions can as yet be reached regarding the function of symbionts in many invertebrate animals, owing to our ignorance of the physiological processes in the associated organisms. The investigation of these problems is one fraught with difficulties, which we must hope will be surmounted.

New knowledge is continually being acquired, and a glance into new and even recent publications shows that symbionts have been repeatedly seen and interpreted as mitochondria or chromidia. Thus in Aphis the long-known pseudovitellus has been shown to contain symbiotic yeasts by Pierantoni and Šulç, independently and almost simultaneously (1910); Buchner (1914) has demonstrated symbiotic luminiscent fungi in the previously well-studied pyrosomes, besides identifying (1921) as bacterial symbionts the mitochondria found by Strindberg (1913) in his work on the embryology of ants. The increasing number of infective diseases of animals and plants, moreover, which have been traced, especially in recent years, to apparently ultramicroscopic organisms, cannot but suggest that there may exist ultramicroscopic symbionts.

From the foregoing summary of what is known to-day of symbiosis we see that it is by no means so rare a phenomenon as was formerly supposed. Symbiosis occurs frequently among animals and plants, the symbionts (algæ, fungi, bacteria) becoming in some cases permanent intracellular inhabitants of their hosts, and at times being transmitted from host to host hereditarily. Among parasites, non-pathogenic and pathogenic, we know of cases wherein hereditary transmission occurs from host to host.

It is evident that we are on the threshold of further discoveries, and that a wide field of fruitful research is open to those who enter upon it. In closing, it seems but fitting to express the hope that British workers may take a more active part in the elucidation of the interesting biological problems that lie before us in the study of symbiosis and the allied subject of parasitism.

Crete as a Stepping-Stone of Early Culture: some New Lights.[1]

By Sir Arthur Evans, F.R.S.

The unique geographical position of Crete, lying almost midway between Europe, Asia, and Africa, marked it as the point where the primitive culture of Europe was first affected by that of the older civilisations of Egypt and the East. But geographically it belonged in late geological times to Anatolia, being separated from Europe by the irruption of an arm of the Miocene Sea which later became the Ægean. Thus the fauna of Crete show nearer connexions with Asia Minor, as, for example, the Cretan wild goat; and this affinity is still reflected in its Neolithic culture, of which at Knossos in places we have a mean thickness of some 6½ metres (23½ feet) as compared with about 5½ metres (19 feet) for the whole of the superincumbent strata.

The builders of the Great Palace had themselves

[1] Abridged from a lecture delivered before Section H (Anthropology) of the British Association at Liverpool on September 18.

removed the earlier Minoan or Post-Neolithic strata from the top of the original " Tell " to form the Central Court, and immediately below its pavement level some traces of rubble masonry appeared, my investigation of which, in the summer of this year, resulted in the discovery of a complete house belonging —as its contents showed — to the latest Neolithic phase.

This has supplied a most valuable record of the final stage in the development of the original culture of the island, still preserving the impress of its fundamental relationship with the mainland to the East. A female clay idol of " squatting " type is in this respect very significant. Still more important is a feature in the house plan itself, not traceable in any dwelling of the pure Minoan Age that has hitherto come to light—the appearance, namely, of the fixed hearth. The same arrangement conforms to the traditional Anatolian usage as illustrated, for example, by Troy and Sindjirli. This arrangement, as we know, was also shared by the primitive house-plans of mainland Greece from Thessaly to the Morea, but in Minoan Crete it was superseded by the use of movable hearths. On the other hand, the " but and ben " type of this Neolithic house with its side magazines itself survived in a religious connexion, as may be seen from the similar plan presented by the little shrine or " Casa Santa " of the Minoan goddess set up on the neighbouring peak of Mt. Juktas.

Whence then did the usage of the movable hearths reach Crete, which also entailed important modifications in structure? There are reasons for bringing this phenomenon into relation with a wave of southern influence which set in about the beginning of the earliest metal age in Crete, and to which was ultimately due the differentiation of the insular culture from that of the neighbouring Ægean region, and the rise of the brilliant Minoan civilisation, which in turn impressed itself on mainland Greece. A variety of evidence can be adduced indicating a very early intercourse between the Nile mouths and Crete, going back even to the age before Menes, when we know that navigation was already well advanced among the Delta population.

Remains of a series of typical predynastic vases of porphyry and other materials have come to light on the site of Knossos, while imitative stone vessels in variegated materials of indigenous fabric date back to similar models. A class of Early Minoan idols, either pointed or square below, claims a similar lineage, and —as Prof. Newberry has shown—the Minoan 8-shaped shield is itself the outcome of that which formed part of the emblem of the Egypto-Libyan Delta goddess Neith. A Minoan goddess holding this shield seen at Mycenæ seems to have been the prehistoric forerunner of Athena, and something of the cult of the Delta goddess also survives in that of the Snake goddess of Knossos.

Later influences of the same Egypto-Libyan class are traceable in certain Cretan bead-seals and amulets of the period succeeding the VIIth Dynasty. So intensive was the predynastic connexion with Crete that it seems possible that, at the time of Menes' conquest, part of the older population had found a refuge in the island.

As no objects due to this intercourse have yet appeared in the Neolithic Strata of Crete, we incidentally obtain a *terminus ad quem* for the close of the Neolithic period in the island. The date of the late predynastic epoch in Egypt cannot on any showing be brought down later than about 4000 B.C.

From the earliest dynastic period in Egypt proofs of direct intercourse with Crete continually multiply; and fresh examples of this, in the shape of fragments of diorite bowls, including a remarkable specimen with ears inside the rim, from the site of Knossos, are now available. Most of these vessels seem to date from the IVth and Vth Dynasties, from which we have the first monumental records of Egyptian sea-going fleets.

One remarkable outstanding phenomenon is that though copies of Egyptian prehistoric and early dynastic stone vessels occur elsewhere in Crete—notably of VIth Dynasty ointment-pots—the originals so far have been found only on the site of Knossos. Knossos from about the close of the Neolithic Age in Crete was thus becoming a staple of commerce with the Nile Valley.

The question thus arises, By what route did these predynastic and protodynastic objects reach this site? In view of the prevailing northerly winds it does not seem probable that early navigators from or to Egypt coasted round the iron-bound promontories of northern and eastern Crete.

Further discoveries made during the course of this year by me at Knossos and in the central region of the island throw a new light on this question. On the southern slope of the site two parallel lines of massive foundations were unearthed—evidently forming part of a monumental approach to the Palace by a broad step-way, starting from a platform on which had abutted a main southern highway. The remains of the paved way itself were brought out on the opposite side of the ravine, which had been crossed by means of a bridge; and explorations in the interior have now made clear the existence of a Minoan road-line crossing the central region of the island. Remains of this, with massive terrace walls below and above, have been followed along the western steep of Mt. Juktas in the direction of the important Minoan station of Visala, and further south are traceable at intervals ascending and crossing the watershed—here about 1800 feet in elevation—and thence heading towards Phæstos and the southern ports.

It is, therefore, probable that the Egyptian trade was conducted by means of the direct sea-passage to these ports and thence by this very ancient transit route to Knossos. While endeavouring, however, to fix the exact site of the Minoan havens, a disconcerting phenomenon presented itself, which is of some geological interest. At Matala, the Roman harbour of Gortyna, the floors of rock-cut tombs of late Greek date lie nearly two metres beneath sea-level, implying a total subsidence of some four metres at least since the beginning of the Christian era. Similar evidence comes out at the Minoan port of Nirou Khani on the north coast, where there is actually a submarine quarry. The subsidence, therefore, probably extends to the whole of central Crete, and is in strong contrast to the fact that at Phalasarna, in the extreme west

of the island, the Roman harbour has been raised from 5 to 5·50 metres above sea-level.

The direct maritime intercourse between Egypt and Crete had also its reaction betimes on Egyptian art. The spiraliform and curvilinear system that Crete itself seems to have received from the North Ægean, which affects Cretan ornament by the third Early Minoan Period—*c.* 2400–2100 B.C.—is taken on in Egypt at a somewhat later date, about the beginning of the XIIth Dynasty. But the system thus implanted in Egypt had in its turn an almost immediate reaction in Crete, and the spiraliform and other curvilinear patterns of the Middle Minoan Age often betray, by their combinations with sacred symbols and the lotus or papyrus, direct indebtedness to the scarab and ceiling patterns of Middle Kingdom Egypt. From Crete in turn these Egypto-Minoan forms passed at Mycenæ and elsewhere to continental Greece. The most characteristic patterns on the grave stelæ of the Mycenæ—often cited as an evidence of northern influence—in fact, belong to this Egypto-Minoan class.

In spite of the very ancient underlying community of Crete and Anatolia, it is clear that the earlier wave of civilising influence came not from the East but from the Nile Valley. Already in Early Minoan times this influence manifests itself in a great variety of ways, and nothing gives a better idea of the intimacy then subsisting than the spread in the island at this early epoch of the Egyptian game of draughts. By the beginning of the Age of Palaces, about 2000 B.C., however, we begin to have definite evidence of direct importation of objects and concomitant influences from the Syrian and Babylonian side. Two cylinders—one from near Knossos—date from the Age of Hammurabi. Hittite forms of signets also occur, and clay tablets of oriental type.

Two very interesting objects in the Roselle collection at New York now make it possible to trace a characteristic class of Minoan libation vessels to a remote Sumerian source, ascribed by Dr. Hall to the time of Ur-Ninā, *c.* 3000 B.C. These are a small bull and a bull's head of diorite hollowed out for the pouring of liquids, much as the Cretan vessels of the same kind that first appear about the beginning of the Middle Minoan Age, a thousand years later. Even the inlaid decoration of these shows a correspondence with that of Cretan steatite examples. "Rhytons" of this class occur also among Hittite remains, and a kindred lion-headed type was known in Syria. It can scarcely be doubted that intermediate links may ultimately be established.

The function of Crete as a stepping-stone is curiously illustrated by the fact that perhaps the most artistic object found in the Mycenæ Shaft Graves was a silver bull's-head rhyton of Minoan fabric, while part of an alabaster example of the lion's-head type, a replica of one from the Temple Treasury of the Palace of Knossos, occurred at Delphi, confirming the tradition that connects its earliest cult with this Cretan site.

Among the contents of the remarkable tomb recently discovered on the site of Byblos, containing obsidian ointment pots with the cartouche of Amenemhat III., were not only a part of a silver bowl with spiraliform repoussé work of a Minoan kind, but also a spouted teapot-like vase of the same material, which has also been attributed to a "Mycenæan" source. The nearest parallel to this is a hitherto unpublished blue faïence vase from the treasury of the Central Sanctuary at Knossos, but the indebtedness here is probably the other way, since similar forms in clay, as is shown from the contents of Hittite tombs, were at home in North Syria.

Together with these oriental connexions the reciprocal intercourse between Egypt and Crete continued to operate on either side, and a curious parallel to the history of the animal rhytons is presented by another series to which an ostrich egg forms the starting point. The Egyptian prototype is actually supplied by a vessel found by Prof. Garstang in an early Middle Kingdom tomb at Abydos and now in the Brussels Museum, where a mouthpiece of translucent blue marble is fitted to an ostrich egg recipient. It is scarcely necessary to mention here the discovery of imported polychrome pottery in XIIth Dynasty deposits in the Fayûm and elsewhere, or of the diorite Egyptian monument—probably the offering of a resident Egyptian—and the alabastron lid with the Hyksos King Khyan's name found at Knossos. It is a pregnant symptom of the maritime enterprise of Crete at the close of the Middle Minoan Age that ships of more advanced type now appear on seals that have been discovered.

The early operation of Cretan influences in Malta has recently received fresh illustration from the incised designs on the pottery of Hal Tarxien and the painted scrolls of the hypogæa of Hal Saflieni. At a somewhat later date it seems possible to ascribe to Minoan or Mycenæan agency—at least in its initial stages—the diffusion of faïence beads of the segmented and other Egyptian types to the Iberic and Britannic West. So, too, the amber-trade from the north by way of the Adriatic coast to the Peloponnese and Crete, which attained its apogee about the beginning of the Late Minoan Age, may account for the survival of Minoan and Mycenæan forms among the relics found in Illyric cemeteries like that of Glasinatz in Bosnia, as well as for certain elements in the affiliated Gaulish and Late Celtic culture.

Of the Minoan relations with inner Africa, either through Egypt or by way of the Libyan ports of the Tripoli region, some striking new evidence has been brought to light by the recent excavations at Knossos. In some of the newly discovered frescoes, apes of the Cercopithecus genus, not found nearer than the Sudan, are so vividly depicted that it is clear that the artist had studied them from the life. Tame specimens must, therefore, have existed in the great Palace, probably introduced through Egyptian agency. Of even greater interest is a frieze in which a Minoan captain in a typical embroidered loin-cloth and wearing a black goat's-skin cap is seen leading a negro troop wearing a similar uniform. It seems more than probable that such black mercenaries reached Crete through some Minoan factory on the Libyan coast. The negro element in Crete, which reached it from Tripoli and Derna under Turkish rule, is still noticeable. The employment by the Minoans of black mercenaries in the days of their expansion on the European side suggests the most modern parallels.

Obituary.

Rev. H. J. Bidder.

THE death of Henry Jardin Bidder, fellow of St. John's College, Oxford, which took place on October 19 at his house in Oxford, deprives his College and University of a wise counsellor and the world of a rare and commanding personality.

Mr. Bidder was born in 1847, and after his school-days at Harrow, spent the whole of his long life in, or in the neighbourhood of, Oxford. He was elected to a fellowship at St. John's in 1873, and having taken Orders, found ample scope for his abounding energy in the service of the Church and in acting as lecturer and tutor and subsequently as Bursar of his College. The post of Bursar he held for twenty-one years, and during that period Mr. Bidder administered the financial affairs of his College with such judgment and ability that when he resigned the office St. John's had become one of the most flourishing colleges in the University.

A man of wide sympathies, Mr. Bidder espoused with enthusiasm the cause of agriculture and forestry in the University. He took a leading part in effecting the re-endowment of the Sibthorpian professorship of rural economy and in the establishment of a professorship of forestry. Nor will it be ungracious to state that the weight of his influence counted heavily in determining his college to give generous assistance to these departments of the University, in assisting in the provision of buildings, and in putting Bayley Wood at the disposal of the School of Forestry as a training ground for foresters. Mr. Bidder served for many years on the University Forestry Delegacy and was also a most valued Curator of the Oxford Botanic Garden.

Of the many services which Mr. Bidder rendered to the world none is more conspicuous nor more widely appreciated than that of making the garden of St. John's College the most beautiful in the University and among the most beautiful in the world. To the lot of few men has it fallen to give pleasure to so many as did he by his labours in making "his" garden more perfect year by year. Those who shared his love of gardening were sure of a warm welcome to St. John's and a warm place in his heart, and there are many who count among the happiest hours of their life those spent with Mr. Bidder in St. John's garden. They were never sent empty away, but received the gifts of his large-hearted friendship and of any, even of his most precious, plants which they desired. The rock garden, designed with consummate skill and tended with meticulous care, was perhaps the achievement of which Mr. Bidder was most proud: and justly, for in it Alpine plants, even the most difficult, found congenial place, and flourished so that they made St. John's rock garden in springtime the most lovely corner of Oxford.

Tall and stalwart, authoritative, broad-minded, not always very patient, but of exquisite courtesy, Mr. Bidder was greatly beloved. He was humorous, too, with a spice of teasing malice which gave piquancy to his conversation and endeared him the more to his friends. His voice was beautiful, and there was a graciousness in his demeanour which made each time of meeting him a memorable occasion. F. K.

Dr. William Crooke.

It is with great regret that we record the death of Dr. William Crooke, the widely-known authority on Indian ethnology, which occurred on October 25 after an operation.

William Crooke was born in 1848, and after taking his degree at Dublin University, entered the Indian Civil Service (Bengal) in 1871. While engaged in official duties as magistrate and collector in the United Provinces of Agra and Oudh, he took up the study of ethnology. As a result, in 1896 he published "Popular Religion and Folklore of Northern India," and "The Tribes and Castes of the North-Western Provinces and Oudh." The latter was undoubtedly his greatest work. It naturally owed much to his predecessors, such as Risley Dalton, Tod, and Malcolm; but it differed from any previous account in supplying a more detailed description of the manners, religions, marriage customs, and institutions of the people. Its most valuable part was the record of Crooke's own observations, made in the course of a long service at Mirzapore, on the Dravidian peoples, whose culture was then rapidly disappearing before Brahmanical propaganda.

On his retirement from the Civil Service, Crooke was for a time honorary secretary of the Royal Anthropological Institute; but he finally settled at Cheltenham and devoted himself to the study of folklore and Indian ethnology. These studies bore fruit in a number of contributions to the proceedings of learned societies and in other publications. In addition to the two books mentioned above he published: "An Indian Glossary," 1903; "Things Indian," 1906; and "The Peoples of Northern India," 1907. He also contributed a large number of articles to Hastings' "Encyclopædia of Religion and Ethics." For many years he was a constant contributor of paragraphs on anthropological subjects to NATURE, and his last contributions were received only a few days before he entered the nursing home where he died.

Crooke's intimate acquaintance with folklore and primitive custom, as well as his wide knowledge of Indian archæology and history, and his explorations in the byways of the literature on India, rendered him an ideal editor. In this capacity he produced Fryer's "New Account of East India and Persia" (Hakluyt Society, 1909); Tod's "Annals and Antiquities of Rajasthan," 1920; and Herklot's "Islam in India," 1921. In each case his work was highly praised by the most competent critics.

In 1910, Crooke was president of the Anthropological Section of the British Association at the Sheffield meeting, and in 1911–12 he was president of the Folklore Society. In 1919 the University of Oxford conferred upon him the honorary degree of D.Sc., and in 1920 his own University of Dublin honoured him with the degree of Litt.D. He had recently been elected a fellow of the British Academy.

We regret to announce the following deaths:

Mr. Charles Burckhalter, astronomer and meteorologist, director of the Chabot Observatory since 1885, on September 20, aged seventy-four.

Prof. H. B. Rathke, formerly honorary professor of chemistry at Marburg University, aged eighty-four.

Current Topics and Events.

THE announcement of the award of the Nobel prize for medicine for 1922 to Prof. A. V. Hill and Prof. Otto Meyerhof, and for 1923 to Dr. Banting and Prof. Macleod, is gratifying to British research in medical science. The Toronto workers who discovered insulin share with workers at home a common inheritance of scientific tradition; their work has attracted much notice and is well known. The division of last year's prize between Prof. Hill and the professor of physiology at Kiel emphasises the friendly co-operation which has marked their work on muscular contraction since the investigations of Fletcher and Hopkins in 1908. Sir Walter Fletcher, now secretary of the Medical Research Council, was Prof. Hill's tutor at Cambridge and urged him to take up physiology. Work on muscle at that time awaited the elaboration of a new technique of investigation. It was Langley who suggested the line of approach which has since proved so productive in the hands of A. V. Hill, whose modification of the thermopile made possible the investigation of the total heat produced in a muscular contraction, of the time-relations of the heat-production, either "initial" or "recovery," and of the thermal changes associated with the passive lengthening or shortening of the muscle. Oxygen is not used in the primary break-down processes of rest or activity, but only in what, strictly speaking, may be called the recovery processes. Prof. Hill has shown that but for the body's ability to meet its oxygen liabilities in arrears, it would not be possible to make more than the most moderate muscular effort. The muscle "goes into debt" for oxygen on the security of the lactic acid liberated in activity. Mechanical response is probably due to the production of lactic acid during contraction, its sudden appearance changing the electrical and colloidal state of protein interfaces in the muscle. Prof. Hill and his collaborators then passed to the consideration of the efficiency and speed of the recovery process, to the use of the "oxygen debt" as an indicator of the absolute amount of lactic acid present in the body at the end of exercise and to other problems of muscular exertion in man. Meyerhof continued in the use of the calorimetrical and chemical methods, his account of the rôle of lactic acid in contraction running parallel to A. V. Hill's. Muscle problems apart, Meyerhof, following Hopkins, has done notable work on the mechanism of oxidation; while A. V. Hill's work on blood-gases and on nervous excitation is also very widely known.

IF committees and talk could satisfy the bibliographic needs of the present-day researcher, he would be happy indeed. Even a body no less august than the International Commission on Intellectual Co-operation, instituted by the assembly of the League of Nations, and presided over by Prof. Bergson, has been discussing the question. Meanwhile, the Committee on Bibliography and Publication appointed by the Union of American Biological Societies has presented its first report (*Science*, September 28, 1923). It proposes to publish one comprehensive series of *Biological Abstracts*, which, at the rate of 6·8 titles to the page, would produce 6000 pages a year. This would be issued in 12 monthly numbers, with a thirteenth, also of 500 pages, for the classified index. The estimated cost of manufacture and distribution is 52,144 dollars, which is to be met by 1000 institutional subscriptions of 15 dollars and 6000 individual subscriptions of 6.20 dollars. These estimates do not include cost of binding (at least 4 dollars per copy per annum), nor do they seem to allow for editorial, bibliographic, and clerical work. Valuable though this volume might be, it would still leave the needs of the systematist to be met by such a work as the "Zoological Record," nor could its classified index, based on brief abstracts, really be what the committee calls "the modern, detailed, searching subject index." The prospect, therefore, is somewhat appalling, and suggests anew that modern scientific authorship will perish under the weight of its own products. But are these 6500 pages, for biology alone, really necessary? Would not an analytic index, competently and honestly compiled, be both less expensive and of greater ultimate value?

MAJOR H. H. KING, writing from the Central Research Institute, Kasauli, Punjab, directs attention to the statement made by Prof. I. P. Pawlow, in his lecture before the International Physiological Congress held in Edinburgh last July, to the effect that he has experimentally demonstrated the inheritance of an acquired nervous character (*British Medical Journal*, August 11, p. 256). The statement, as Major King suggests, is so far-reaching in its significance, that the results of the further experiments now in progress will be eagerly awaited. Up to the time of his leaving Russia, Pawlow's experiments had not demonstrated the direct inheritance of an acquired or "conditioned" reflex in the form of an inborn or "unconditioned" reflex; what he claimed to have shown was that the acquisition, under identical treatment, of a "conditioned" reflex became increasingly rapid in successive generations of mice. It is clear, however, that his results had led him to regard it as probable that eventually, after a sufficient number of generations had been exposed to the training, the period of training needed would fall to zero, and the reflex, acquired in the earlier generations by oft-repeated association, would eventually appear as an inborn, unconditioned character. It would be worse than useless at this stage to discuss the possible meaning or mechanism of such a process. We must await the confirmation and full exposition of the facts. But it must, in any case, be regarded as an event of the highest significance that an observer of such pre-eminence, and so intensely objective in his methods, should have been led even to such preliminary conclusions.

A VALUABLE addition to the collection of old maps in the British Museum has been made by the purchase of a hitherto unknown Italian world map dated 1506. A reproduction of the map is given in the *Geographical*

Journal for October, and in an accompanying article Mr. E. Heawood explains that the author was Contarini, who appears to be quite unknown as a cosmographer, and that Roselli was the engraver and perhaps the publisher. The map may have been produced at Venice, but there is also some evidence that it appeared at Florence. In some respects it is reminiscent of the map of Johan Ruysch of 1508, but in detail there is little close agreement. The resemblance is greater with Waldseemüller's map of 1507, but Mr. Heawood believes that this is due to a use of common sources. In Europe the general outlines, except in the north, are good. The outline of Africa is striking and much better than Waldseemüller, but the interior topography is almost entirely Ptolemaic. There is an extraordinary misplacement of the Blue Nile, derived, Mr. Heawood believes, from some early maps then existing in Italy. The chief interest in the map, however, lies in its being the first to show the result of Columbus' voyages. The priority that passed from Ruysch to Waldseemüller must now be yielded to Contarini. The author was evidently alive to the possibility of South America being a large continent, but there is no indication on his map of any land barrier closing the western seaway to Cathay. The article includes a facsimile of the map.

MR. ALAN G. OGILVIE, who has succeeded Mr. G. G. Chisholm as lecturer in geography in the University of Edinburgh, gave his inaugural address, "Modern Geography as a Study and as an Aid," on October 12. He pointed out that the great volume and complexity of the data comprised by the various natural and humane sciences result in an increasing need for work of correlation and synthesis such as geography performs. In this the data furnished by other workers are discussed by geographers always in relation to place. The study of regional geography is still in its infancy, for complete regional monographs based upon field work exist for only a small part of the earth's surface; and synthetic regional study is the main function for geographical research in the future. In regions largely unsurveyed the compilation of provisional maps can be best carried out by persons well trained in physical geography, and such maps are urgently required by men of science working in relatively unknown areas. Much fruitful investigation will result from the collaboration of geographers with workers in other fields such as geology and biology, archæology and history, economic and social science. Geography along with other sciences can help towards a reasonable and gradual redistribution of the world's population, thus relieving the stress due to overcrowding, by directing the streams of suitable emigrants to lands in which they can flourish.

THE position of the Chemical Hall in the British Empire Exhibition at Wembley next year is in many ways a good one. Visitors to the Exhibition arriving at Wembley Park Station will enter at the north entrance, and the Palace of Industry is on the right-hand side of the main avenue which runs straight to the Stadium—north to south. The Chemical Hall is in the north-east corner of the Palace of Industry: it is surrounded by two of the 75-foot gangways, and there are three main entrances to it. The exhibits will be grouped roughly in five divisions: (*a*) Heavy chemicals; (*b*) dyestuffs and intermediates; (*c*) fine chemicals; (*d*) soap and perfumery; and (*e*) scientific. A scientific committee consisting of the following representatives of scientific societies has been appointed: Mr. J. Baker, Mr. F. H. Carr, Mr. E. V. Evans, and Dr. Herbert Levinstein (Society of Chemical Industry); Dr. J. T. Hewitt and Prof. J. F. Thorpe (Chemical Society); Mr. J. B. Atkinson (Society of Dyers and Colourists); Mr. T. Marns and Mr. E. T. Neathercoat (Pharmaceutical Society); Dr. Stephen Miall (Federal Council); Mr. R. Pilcher (Institute of Chemistry); Commander R. E. Stokes Rees (Institution of Petroleum Technologists); Prof. J. W. Hinchley and Mr. W. J. U. Woolcock (Institution of Chemical Engineers). Mr. Woolcock is serving on all the committees concerned with the scientific side of the Exhibition, in order to act as general liaison officer and to avoid undue overlapping.

REPORTS have recently appeared in the Press of great changes in the depths of the South Atlantic. A note in the *Geographical Journal* for October states that the Hydrographer to the Admiralty contradicts these statements. They arose apparently from the existence, which is well known, of a ridge with depths of 480 fathoms about 800 miles from the Cape on the direct route of the cable between St. Helena and the Cape. Repairs to this cable have lately brought into prominence the occurrence of this ridge in contrast with the surrounding depths of 2500 fathoms and upwards.

THE introduction of European animals into Australia has produced a noticeable diminution in the numbers of many of the native species, some of which appear to be on the verge of extinction. In these circumstances the Trustees of the British Museum thought it desirable to acquire examples of the Australian fauna, particularly mammals and birds, and they sent out a collecting expedition for that purpose. The leader is Capt. George H. Wilkins, who was a member of the Stefansson Arctic Expedition and biologist on the *Quest*. The first station chosen for collecting was in southern Queensland, about 350 miles inland; work was carried on in this area from April 25 to June 11, and the specimens obtained there have recently arrived at the Natural History Museum. The second station is in northern Queensland.

THE first number of the new monthly publication, the *Journal of Scientific Instruments*, dealing with the principles, construction, and use of scientific instruments, has appeared. It is produced by the Institute of Physics with the co-operation of the National Physical Laboratory and is a quarto of 32 pages sold at 2*s*. 6*d*. There are three articles of considerable length on temperature control for the Pulfrich refractometer and on the measurement of heights by aneroid and of internal diameters of transparent tubes. Shorter articles on a new relay,

a recording drum, a balance in which the fine adjustment is made by a chain hanging from the pan, and a recording katathermometer, followed by two pages of notes and reviews, complete the part. The character of the articles and illustrations promises well for the future of the *Journal*.

THE twenty-seventh annual meeting and autumn foray of the British Mycological Society was held at Windsor on September 28-October 3. The president, Prof. O. V. Darbishire, dealt generally with the subject of lichens in his address. Lichenologists of the last century, typified in the person of William Nylander (1822–1899), were almost entirely opposed to Schwendener (1829–1919). They felt that his theory of the dual nature of lichens was not true and that the autonomy of the group of lichens was threatened. This old contrast between systematist and physiologist is now almost gone. Systematic lichenology is now in such a state that an appeal is made to lichenologists to work through lichen groups, genera or even species monographically. The difficulty of defining a lichen-species is often very great. This is in part due to the fact that the lichen fungus, anatomically as a rule the predominant partner, in the simple system of symbiotic co-operation existing in the lichen, has thrown overboard the structural traditions of its free-living saprophytic or parasitic ancestors. The result is that the rock-forms of two allied species will in structure often be more like one another than they will be like their respective normal bark-inhabiting parent forms. The evolution of the lichen is proceeding along very definite lines, from the flat crustaceous but areolate, to foliaceous, upright foliaceous, and finally true fruticulose forms. The highest physiological differentiation is reached in such forms as Cladonia, where we get stem and dorsiventral leaf clearly separated. Other papers were contributed on "Epidemic Plant Diseases," by Mr. F. T. Brooks; "The Fungi found growing in a Blackbird's Nest," by Sir H. C. Hawley; and an account by Mr. J. Ramsbottom of "An unpublished Monograph on Discomycetes by M. C. Cooke." Mr. J. Ramsbottom was elected president for 1924, Miss G. Lister vice-president, and Messrs. W. J. Dowson and C. J. Sharpe to the council.

THE autumn meeting of the Society of German Chemists was held at Jena on September 26-29, and about six hundred members were present in spite of the present difficulties. No festivities of any kind took place, except the performance of Goethe's play, "Stella." The following were among the subjects of scientific lectures in a very full programme:—Prof. Dr. Neuberg: Review of recent research in fermentation chemistry, and demonstration of methods of determining the direction of fermentation and fixing intermediate products. Prof. Lemmermann: The position of Germany as regards supply of artificial fertilisers; the prospects of enlarging the yield to such an extent that Germany can grow her food supply at home. Experiments were described for partially replacing phosphoric acid by colloidal silicic acid. Dr. Edeleanu: Description of the process of refining certain kinds of petroleum (such as Rumanian and Californian) containing a large amount of unsaturated and benzolic hydrocarbons by liquid sulphurous acid, and of the apparatus constructed for this purpose by the Borsig Works. This process permits the manufacture of a good burning oil and the production of the other components of the petroleum in their original condition. Prof. Dr. Stock deplored the poor financial condition of experimental chemistry at the German high schools, and remonstrated against the reduction of this most important branch of chemical education. Prof. Dr. K. Hess: Review of recent researches on cellulose. The simple cellulose molecule is represented by $C_6H_{10}O_5$, as stated by Prof. Green thirty years ago. Detailed investigation of the cuprammonia solution of cellulose has proved this to be correct. Prof. Linck: A new proposal for the working-up of the magnesium chloride waste liquors in potash works. In ten sections more than eighty lectures were given on various problems of pure and applied chemistry, industrial law, education, etc.

THE annual report of the Meteorological Committee to the Air Council for the year ended March 1923 has just been issued; this is the sixty-eighth year of the Meteorological Office. Of recent years much development and extension has occurred consequent on the necessary investigation of the upper air for the requirement of aircraft and for naval and military purposes. Most public meteorological work is now absorbed under Government management, and without doubt this tends greatly to the advancement of meteorology. The system of wireless weather reports from ships in the Atlantic is said to be extremely efficient, the whole of the work on the ships is voluntary, and no "ships' charges" are made by the Marconi Company. Some return is made for this voluntary help by broadcasting two messages a day specially prepared by the Office for the shipping approaching our western coasts. About 500 ships regularly and voluntarily send returns in connexion with the work undertaken by the Marine Division, and discussions of use to seamen are actively maintained. The Forecast Division is on the alert to take advantage of every opportunity to ensure improvement in the accuracy of the forecasts. In addition to the European observations, data are received daily from 29 stations in the United States, from Iceland and Greenland, and occasionally from the steamship *Maud* of the Norwegian Polar Expedition. Forecasts are prepared three times each day for issue to the Press and special week-end forecasts are prepared on Thursday and Friday. The Climatological Division deals with all information bearing on climate. Upper air observations entail much work, and the British Rainfall Organisation is entirely under the control of the Meteorological Office.

SIR HUMPHRY ROLLESTON has been appointed a physician-in-ordinary, and Mr. E. F. Buzzard physician extraordinary, to the King.

MR. T. SHEPPARD, of the Hull Municipal Museums, and Dr. T. W. Woodhead have been elected honorary

life members of the Leeds Naturalists' Club and Scientific Association, in recognition of their work in Yorkshire.

DR. J. H. JEANS will deliver the Van der Waals memorial lecture at the meeting of the Chemical Society to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, on Thursday, November 8, at 8 P.M.

SIR OLIVER J. LODGE will deliver his presidential address to the Röntgen Society on "X-rays and the Atom," at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2, on Tuesday, November 6, at 8.15 P.M. Tickets of admission can be obtained from the Hon. Treasurer of the Röntgen Society, 33 Newton Street, W.C.2.

SIR ARCHIBALD GARROD, Regius professor of medicine at Oxford, is to deliver the Harveian oration of the Royal College of Physicians of London in 1924. Dr. C. Singer will deliver the FitzPatrick lectures on November 6 and 8, at 5 P.M., on "The History of Anatomy," and Mr. Edmund Gosse the Lloyd Roberts lecture on "Personal Relations between Medicine and Literature," on Tuesday, November 20, at 5 P.M.

DR. ANDREW BALFOUR has been appointed by the transitional executive committee, under the chairmanship of the Minister of Health, to be Director of the School of Hygiene which is to be established in London. The foundation of the School, which was referred to in NATURE of July 28, p. 149, was made possible by a gift of two million dollars by the trustees of the Rockefeller Foundation.

SIR J. FORTESCUE FLANNERY has accepted the invitation of the Council of the Junior Institution of Engineers to become president of the Institution in succession to Capt. H. Riall Sankey. His induction will take place at a meeting to be held at the Royal Society of Arts on Friday, December 7, when he will deliver his presidential address, "Marine Propulsion during fifty years." Tickets for the meeting may be obtained from the Secretary of the Institution, 39 Victoria Street.

A DISCUSSION on "The Reproduction of Sound by Loud Speakers," arranged by the Physical Society and the Institution of Electrical Engineers, will be held on November 29 in the hall of the Institution of Electrical Engineers. There will be two sessions, 5.30-7 P.M. and 8-9.30 P.M., and during the afternoon visits will be made to the studio of the British Broadcasting Company at Savoy Hill.

FROM the income of the R. 38 Memorial Prize Fund, a sum of twenty-five guineas will be offered as a prize for the best paper received by the Royal Aeronautical Society, on some subject of a technical nature in the science of aeronautics. Other things being equal, preference will be given to papers which relate to airships. The prize is open to international competition. Intending competitors should send their names to the Secretary of the Royal Aeronautical Society, 7 Albemarle Street, London, W.1, on or before December 31, with such information in regard to the projected scope of their papers as will enable arrangements to be made for their examination. The closing date for the receipt of papers will be March 31.

A PLANT Pathologist is required in the Botanical Division of the Department of Agriculture of the Union of South Africa. The duties of the post will primarily be connected with carrying out pathological investigations regarding the outbreak of disease in tobacco. Candidates must possess a university degree and have taken botany and the allied sciences in the final examination. Forms of application may be obtained from the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2. The latest date for the receipt of applications for the position is November 20.

AT the statutory meeting of the Royal Society of Edinburgh held on Monday, October 22, the following officers were elected :—*President*: Prof. F. O. Bower; *Vice-Presidents*: Major-General W. B. Bannerman, Dr. W. A. Tait, Principal J. C. Irvine, The Rt. Hon. Lord Salvesen, Prof. J. H. Ashworth, and Prof. T. H. Beare; *General Secretary*: Prof. R. A. Sampson; *Secretaries to Ordinary Meetings*: Dr. A. Lauder and Prof. W. Wright Smith; *Treasurer*: Dr. J. Currie; *Curator of Library and Museum*: Dr. A. Crichton Mitchell; *Councillors*: Prof. H. Stanley Allen, Sir Robert Blyth Greig, Dr. J. Ritchie, Prof. E. Maclagan Wedderburn, Prof. T. H. Bryce, Prof. J. Y. Simpson, Prof. D'Arcy W. Thompson, Sir James Walker, Prof. E. T. Whittaker, Prof. H. Briggs, Mr. W. L. Calderwood, and Prof. T. J. Jehu.

THE annual meeting of the British Association of Chemists was held in the Chemical Department of the University of Birmingham on Saturday, October 27, under the presidency of Dr. Herbert Levinstein, who was re-elected for another year of office. During this meeting the laboratories and workshops of the University were thrown open for inspection and an exhibition of research apparatus and specimens was arranged by the teaching and research staffs of the University. The British Association of Chemists, which was founded in 1917, exists to safeguard the economic and general interests of chemists and to secure wider recognition of the national importance of the profession. The qualifications for admission to full membership are either (1) a university degree or equivalent diploma with one year's practice in applied or teaching chemistry, or (2) a sufficient general education and scientific training with seven years of professional practice. At the present time there are about 920 full members. This Association issues a quarterly Bulletin in which are published the annual report of the Council, the Proceedings of the Association, and other matters appertaining to the material and professional welfare of its members. These activities include an unemployment benefit fund, an appointments bureau, and a legal aid fund.

THE Streatfeild memorial lecture was delivered at the Finsbury Technical College on October 25 by Mr. E. M. Hawkins, who took analytical chemistry

as his subject. First among the qualifications required in the analyst is accuracy and trustworthiness, to which should be added the ability to decide to what degree of accuracy his results attain. Secondly, there is the need for rapidity to be associated with accuracy, as few students realise the speed of manipulation which is required of them when they obtain a post after leaving college. Thirdly, it is of great importance that students should cultivate the gift of expressing results suitably in a report. Much good experimental work is marred by the inability of the chemist to write up his results in such a way that the bearing of the work can be properly appreciated by those who read the report. The chemist should not be easily moved from an opinion formed after careful consideration of results obtained by patient investigation. In conclusion, the lecturer stated that of the three classes of men practising chemistry, namely, works chemists, public analysts, and consultants, the first class will greatly outnumber the public analysts when trade revives, while consulting chemists will be men of wide experience and high attainments who will be called upon by manufacturers to solve their problems and should be highly remunerated for such work.

MESSRS. WHELDON AND WESLEY, LTD., 2 Arthur Street, W.C.2, have just sent out a new catalogue (New Series, No. 9, 1923) of second-hand works on ornithology, compiled with their usual care. It contains nearly 1300 titles, and should be seen by all interested in the subject.

MR. W. H. ROBINSON, 4 Nelson Street, Newcastle-on-Tyne, has just issued catalogue No. 9, 1923, of "Rare and Standard Books" offered for sale by him. Many books of science, voyages, and travels are included, and there is a very interesting section on "Americana."

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, W.C.1, have just issued a list of the new books and new editions added to their Medical and Scientific Circulating Library during August and September. As it is practically a list of the medical and scientific books published during the months in question it should be a useful guide to others than subscribers to the library.

PART III. of Sotheran's Catalogue of Science and Technology has just reached us from the publishers (140 Strand, W.C.2). It gives the titles of, and in many cases comments upon, upwards of 1500 works on the subjects of astronomy and astrology, chronology, geodesy, horology, and dialling. Many very rare books are included, among them being a unique star atlas entitled "Uranographia Britannica," published in 1750 and reported to be hitherto unknown. The catalogue should be seen by all who are interested in books dealing with the subjects named.

MESSRS. W. AND G. FOYLE, LTD., 121-125 Charing Cross Road, W.C.2, have sent us a copy of their catalogue (Dept. No. 3, September) of second-hand books, some 700 in number, which they have for disposal. The catalogue is classified under the headings: General Science, Mathematics, Astronomy and Surveying, Mathematical Tables, the New Physics, General Natural History, Anthropology and Ethnology, Evolution, Variation, Heredity, Genetics, Botany, Zoology, Microscopy, Collectors' Manuals, Geology, Palæontology, and Biography. We learn that Messrs. Foyle have recently organised a new department for the supply of books relating to science.

Our Astronomical Column.

NEW COMET.—The first cometary discovery of 1923 was made on October 14, at $13^h\ 18^m{\cdot}2$ G.M.T., by Mr. Doubiaco at Kasan. The comet was of magnitude 8·0, and its position was R.A. $7^h\ 46^m\ 42^s{\cdot}67$; south declination, $20°\ 37'\ 31''$. The daily motion was $+6^m\ 40^s$; south, $4°\ 51'$. The rapid motion indicates that the distance from the earth was small.

Unfortunately, owing to delays in Russia, the news did not reach western Europe until October 25, and by that time it may be inferred that the comet had passed below our southern horizon.

TWO LARGE FIREBALLS.—Mr. W. F. Denning writes that on the evenings of October 16 and 17 very fine meteors were seen in the south-west of England. The first appeared on October 16, at 9.28 P.M., and was well observed by many persons in the counties of Gloucestershire, Somerset, and Devon. It gave a brilliant illumination. Its height was from about 63 to 44 miles, and it passed from above Poole, Dorset, to a few miles south-west of Reading. The radiant point was indicated in Aquila at 301°–9°.

The fireball which appeared on the following night, October 17, at 11.57 P.M., was of extraordinary splendour, and created a startling effect upon many persons who were in a favourable position for witnessing its full effect. About ten observations have come to hand from Cornwall, Devon, Gloucester, and Somerset, and from these it is indicated that the fireball pursued an horizontal flight at an elevation of about 55 miles above the earth's surface. The radiant point was situated in Hercules and not far from the north-western horizon at the time of the meteor's appearance. The illumination it gave was estimated as greater than that of the full moon, and during its flight the nucleus gave a succession of three vivid outbursts of remarkable intensity.

THE SPIRAL NEBULÆ.—Mr. J. H. Reynolds replies in the October issue of the *Observatory* to the articles of Prof. Perrine and Mr. Gifford in the September number. The latter had objected that the number of the spirals approached half a million, which would give an improbably high mass, if they were composed of dust expelled from the Galaxy. Mr. Reynolds notes that many of the small nebulæ suspected to be spirals at the Lick Observatory have been shown at Mt. Wilson to be nebulous nuclei of a different character from spirals. The number of known spirals does not exceed 2000.

The great difference of illumination between the nucleus and the outer portions of the spirals is considered fatal to their being external galaxies similar to our own.

Further, the unsymmetrical distribution of the spirals in galactic longitude has to be considered in any discussion of their nature.

Research Items.

GYPSY SLAVERY.—Dr. M. Gaster, in the Journal of the Gypsy Love Society (Third Series, vol. ii., Part 2) publishes a remarkable series of facts drawn from a case decided in Moldavia in 1851, which shows that at that time the sale of Gypsies must have been comparatively common, as there seems to have been a fixed, or at any rate normal, price at which slaves were sold. The persons offered for sale fall into four groups, including various trades, some hereditary and others in which the son practises a craft different from that of the father. Sales of this kind go back at least to the beginning of fifteenth century.

THE SECRETARY HOUSE IN MARYLAND.—Mr. L. V. Lochwood contributes to the Brooklyn Museum Quarterly (July 1923) an account of this historic house. The site was granted to Henry Sewall of London, who arrived with his family in Maryland in 1661 and the house was named after him, Secretary of the Province, a large landowner, and a man of high importance. It was occupied by him and his family until his death in 1665 and the remarriage of his widow to Charles Calvert, 3rd Baron Baltimore, third Land Proprietor of Maryland. The house is of brick laid in Flemish bond, and is a typical seventeenth century Virginia or Maryland house of the wealthy class. All the furniture shown in the house at present dates before 1725. Mr. Lochwood's article fully describes this interesting building and its contents, and is illustrated by a series of good photographs.

ANTIQUARIAN WORK IN EGYPT.—In *Ancient Egypt* (Part 2, 1923) Sir W. Flinders Petrie describes an important tomb on the shore-cliff at Byblos, twenty miles north of Beyrut. A fine obsidian vase bears the name of Amenemhat III. and the tomb may be safely assigned to the period of the XIIth dynasty. The Syrian objects are of even greater importance, as the tomb furnishes a firm starting point for the dating of Syrian types, and for the relations of Egypt with Syria. This paper is followed by a report by M. Noel Giron of the French Embassy on a tomb found at Sheykh Fadl in the eastern deserts, dating from the Old Kingdom and containing Aramaic inscriptions. These point to a Jewish settlement so far up in Egypt as early as the reign of Manasseh, and the mention of Tirhaka shows that the family went back to eighty years before the fall of Jerusalem. Their natural familiarity with Greek words, objects and thoughts through the Greek camp of Tahpenes throws strong light on the criticism of the prophetic books.

THE CHINESE JUNK AND SAMPAN.—At the ninth Indian Science Congress, the proceedings of which are reported in the Journal of the Asiatic Society of Bengal, New Series, vol. xviii., 1922, No. 6, Mr. J. Hornell, comparing the Chinese junk and sampan, concludes that the sampan is ultimately derived from a modification of the double canoe in use until comparatively recently for sea work throughout Polynesia, and in a simple form still employed on inland waters in India, and that the junk is in turn a development of the sampan type. The truncate transom bow and stern of the sampan probably represent cross planking fitted between the bows and sterns of the two canoes forming one double canoe, while the two projections that curve upwards from the stern of the sampan appear to be the homologues of the up-curved sterns of the two hulls in the double-canoe form. In the some way, the median rudder of the sampan and the junk and the anchor platform that gives a square-bow appearance to the junks are what would be expected if these crafts developed from two canoe hulls joined together by a planked deck platform. The facts point to the range of the sea-going double canoe having extended in former days to India and China, the inventors and users being the ancestors of the present Polynesian race, who probably occupied the maritime districts of China at the time the Chinese left their original homeland in north-east Central Asia.

CATTLE AND EXCITEMENT FROM BLOOD.—In the *Psychological Review* (Vol. 30, No. 5) Prof. G. M. Stratton gives a very interesting account of his attempt to verify a popular belief. It is widely held that cattle react powerfully and perhaps instinctively to blood, and to get definite expression of this view from persons accustomed to observing cattle, he obtained testimony from a large number of cattlemen. They all replied to the effect that nothing else is so irritating or exciting to cattle as the smell of blood. As to the kind of emotion aroused, there was less unanimity, some ascribing it to anger, others to fear, aversion, or curiosity. The reports, however, were quite clear that blood did have a marked emotional effect. To determine the truth of these views, experiments were carefully conducted on cattle in the Berkeley Hills. Both cow's and horse's blood were used under careful experimental conditions. The experiments proved, however, more exciting to the experimenters than to the cattle. In general, the observations showed that while individual cattle displayed mild interest, there was little of that excitement spoken of by the cattlemen, no herd-seizure of alarm or rage. The author concludes, not that the cattlemen had no grounds for their belief, but that they were wrong in ascribing the excitement to blood alone; when excitement occurred it was probably due to the presence of blood in union with other factors—*e.g.* with cries of pain, or with the sight of wounded cattle. He believes that the reaction of cattle to blood, and probably of human beings too, is less of a native physiological reflex than is commonly thought, being largely influenced by special experience.

AN ARTIFICIAL PLANT CELL.—Dr. D. T. Macdougal has found an interesting method of attack upon the problem of the permeability of the plant cell and the factors that cause it to vary (Proc. Amer. Phil. Soc., vol. 62, pp. 1-25, 1923). He converts a Soxhlet extraction thimble into a semi-permeable cell by impregnating the cellulose with various substances analogous to those entering into the composition of the natural plasma membrane and plant wall, such as pectin, agar, lecithin, etc. Subsequently the rate of endosmose of such cells is noted when they are filled with sugar solution and immersed in external solution containing different salts. The rate of entry of these salts into such cells can be followed by conductivity measurements; the exosmosis of sugar can also be estimated quantitatively. Potassium ions show a high rate of penetration into such cells, with very little action on the colloid in the wall; calcium, on the other hand, penetrates least, but exerts a powerful aggregating effect upon some of the colloids. The rate of endosmose into the artificial cell increases as the permeability is lessened, and is thus usually most vigorous when immersed in the solution of a calcium salt.

OILS FROM INDIAN PLANTS.—The Indian Institute of Science, Bangalore, continues to publish in its Journal, under the editorship of Dr. M. O. Foster, the results of the examination of the natural products of

India. Among recent papers may be noted two from the Department of General and Organic Chemistry, namely: (1) a report upon cashew kernel oil by C. K. Patel, J. J. Sudborough, and H. E. Watson (vol. vi. part 6). The cashew nut is the fruit of *Anacardium occidentale*, Linn., an evergreen tree indigenous to S. and Central America, now cultivated in India. The nut contains some 42 per cent. of oil, but has not been much used as a source of oil, because of its ready sale for dessert and for use in the preparation of nut chocolate. (2) Hongay oil, extracted from the seeds of one of the commonest of Indian trees, *Pongamia glabra*, Vent., is used in Hindu medicine for the treatment of skin diseases; the oil has been fully reported upon by R. D. Desai, J. J. Sudborough, and H. E. Watson (vol. vi. part 5). From the Biochemical Department appears a paper by Gilbert J. Fowler and Talwar Dinanath (vol. vi. part 7) upon the production of sugar during the ripening of the fruit of *Bassia longifolia*. The seeds of this plant are used for oil, and the authors point out, as possibly of commercial significance, that, if the fruit is gathered and stored a few days under suitable conditions, sufficient sugar may be found in the pulp after removal of the seeds to make this waste product available as a source of alcohol upon fermentation.

Soil Acidity and Light Intensity.—In a pamphlet published by the Cambridge University Press entitled "Studies in Soil Acidity—the Importance of the Light Factor," Mr. J. L. Sager gives an account of ecological studies carried out in the Alpine Laboratory of "La Linnaea," Valois, Switzerland. Soil samples were taken near the roots of dominant plants in and around the forests of a district characterised by gneiss, granite, and schists. Hydrogen ion concentration measurements were made by the colorimetric method on extracts prepared by shaking the soil with water and filtering after standing for thirty minutes. Tables of P_H values, dominant plants and amount of shade show that several plants, usually described as calcicole, are not confined to the alkaline soils and also bring out a correlation between soil acidity and light intensity. The acidity of the soil steadily decreases on passing from the deep shade of the spruce forest, through the lesser shade of the larch forest, to the open; whilst the soils exposed to the scorching sun at still higher altitudes above the forests are only slightly acid. Cases of high acidity with high light intensity occur only where the soil is badly aerated or frequently waterlogged. The author advances the hypothesis that light is able to lessen the acidity of the soil.

Species-crosses in Cochlearia.—The condition of polyploidy, or species with one or more extra sets of chromosomes, is being found with surprising frequency in plant genera. The latest case of the kind is described by Mr. M. B. Crane and Miss A. E. Gairdner (*Journ. Genetics*, vol. 13, No. 2) in species of Cochlearia. They find that *C. officinalis* and *C. alpina* have 28 chromosomes, *C. danica* 42, and *C. anglica* 49-50, all the numbers being thus multiples of 7. They have also made crosses between the various species, with interesting results that are as yet incomplete. The range of variation of the F_2 offspring is in some cases greater than the combined ranges of the parents. The interesting condition is disclosed that the forms with higher chromosome number do not have larger nuclei, and there is some indication that the higher numbers have arisen through some process of fragmentation or transverse fission. Further investigation will lead to a more complete analysis of the changes involved. This is also the beginning of a valuable and much-needed increase in our knowledge of species-hybrids.

The Molluscan Genus Sculptaria.—In west and south-west Africa there is found a small but beautiful little genus of land shells first described by L. Pfeiffer in 1855 under the name Sculptaria. This has been recently proved anatomically by Dr. E. Degner (*Arch. Molluskenk.*, 1923, No. 4) to belong to one of the more primitive groups of helicoids, the Endodontidae. A considerable collection of these shells, which was made by Mr. P. R. Frames when serving with the Northern Force in the campaign in German South-west Africa in 1914–15, having been placed with other material in the hands of Mr. H. C. Burnup, he has been able to give a monographic account of the genus (Ann. Natal Mus. vol. v.). Three new species are described, bringing the total up to eight, and the whole are carefully differentiated and illustrated with excellent figures drawn by the author himself.

Standard Inductance Coils.—The Bureau of Standards has issued a leaflet giving detailed instructions for the construction of a series of single layer inductance coils suitable for laboratory standards. The series of "inductors," 17 in number, have been designed to cover the approximate inductance range of 8 to 5000 microhenries. Each successive coil arranged in order of magnitude and beginning with the smallest has 50 per cent. greater inductance than the preceding coil. Very little mechanical skill is required to make these coils. It is a real step in advance when you can give instructions at once to a mechanical assistant to make coils of any specified inductance. These coils in conjunction with a variable air condenser form a very accurate and trustworthy wavemeter. Full working diagrams are given, and the costs for material and labour are very small. To those who remember the difficulties of measuring or calculating small inductances twenty years ago, the ease with which standard inductances, even those which have to be used with high frequency current, can now be constructed, is wonderful.

Interferometer Experiments in Acoustics and Gravitation.—The Carnegie Institution of Washington issues as Publication No. 310 a report by Prof. Carl Barus on further experiments in which the interferometer is used for the measurement of very small quantities. These are in the main a development of the acoustic investigations with the pin-hole probe already described in Publication No. 310, 1921. Pressure variations at a node are converted into static pressures through the intervention of the pin-hole and measured at a mercury U-gauge, read by displacement interferometry. The pin-hole probe responds effectively to nodes in organ-pipes, but ignores the antinodes. With a device so sensitive to nodal regions the construction of a pin-hole resonator suggested itself. Great difficulty was encountered in the construction of the pin-hole. Both the size and the slope of the walls are critical. A salient pin-hole generates acoustic pressure, a re-entrant pin-hole acoustic dilatation, and there is neutral behaviour between the two. Within its restricted field the pin-hole resonator serves admirably for the acoustic survey of the interior of a room in which an organ pipe is sounding. If the phenomena were visible, the room would probably have the stratified appearance of a vacuum-tube stimulated by electric discharge. For a given position of the pipe, nodal regions alternate with anti-nodal regions, quite irregular in distribution but none the less fixed in position. An account is given also of work on gravitation, in which an endeavour is made to ascertain with what accuracy the constant may be found in a self-contained apparatus under ordinary laboratory conditions. The results are encouraging, but the experiments are not yet completed.

Physical Chemistry and Physiology at the British Association.

INTERFACIAL PHENOMENA.

IN the Physiology Section, at the recent meeting of the British Association at Liverpool, important communications on this subject were given by Prof. W. Ramsden and collaborators, and some remarkably pretty demonstrations were shown.

Mr. J. R. Bruce and Prof. W. Ramsden showed that egg-albumin became irreversibly coagulated at the gas-water surface, even when all such mechanical disturbances as could compress the adsorbed protein film laterally were strictly excluded. The solubility or insolubility of the adsorptum was ascertained *in situ* by subjecting the rigid adsorption surface to three different treatments :—(1) it was washed from below with large volumes of water ; (2) bile salt was introduced into the depths of the underlying solution ; (3) it was made continuous with a surrounding surface of water maintained in a clean condition and of full normal surface-tension. If the surface rigidity persisted, it was argued that the adsorbed protein had lost its initial solubility. It was concluded that with egg-albumin coagulation took place by the catalytic influence of surface-conditions, and that gross mechanical factors played no essential part,—"mechanical surface coagula" should be termed "massed surface coagula."

True coagulation was a dehydrating condensation of the amino and carboxyl groups of large numbers of neighbouring protein molecules. Metaprotein formation was a precisely similar condensation of a relatively small number of molecules. The size of the complexes formed depended mainly on the concentration of the protein at the time when the reacting groups were activated. Protein adsorbed at a gas/water interface was highly concentrated and the denaturation which followed resulted therefore in the production of coagulated protein. It was also shown (by method 3) that egg-albumin, fibrinogen and edestin became irreversibly coagulated within less than five seconds of attaining a gas-water surface.

Mr. J. Brooks and Prof. W. Ramsden showed that interfaces between water and benzene or water and paraffin in the presence of various emulsifying soluble solids were in some cases mobile, in others rigid. The existence of such mobility showed that Bancroft's theory that stabilisation of emulsions was effected by a *continuous* emulsifying shell with two different surface tensions on its two faces was in need of important modification.

In cases where the emulsifying substance consisted of insoluble solids in fine suspension, evidence was given that the chief factor determining which of the two liquids became dispersed in the other was the angle of contact formed between the liquid-liquid interfaces and the sides of discrete solid particles. Methods were given for ascertaining in which of the two liquids the angle of contact was obtuse, and it was found that in every case it was this liquid which became dispersed in the other.

The demonstrations, given by Prof. W. Ramsden and Miss A. Mackenzie, to illustrate experiments on surface-films, were very beautiful. One simple experiment to illustrate the rigidity of surface-films in certain cases can easily be repeated by any one : a light magnet is floated on the surface of a saponin solution, and an ordinary pivoted magnetic needle immersed in the same solution. On bringing a magnet near to the vessel, the surface magnet remains stationary, while the immersed one follows the movements of the magnet outside just as readily as it would do in air.

As Prof. Donnan pointed out in his presidential address to the Section of Chemistry, many substances spread on water surfaces to a stable film, one molecule thick. All the molecules appear to be oriented parallel to one another and perpendicular to the surface. Mr. N. K. Adam, who has employed this method for the determination of the cross-sectional area of molecules, gave a demonstration at the scientific soirée of the method of procedure. He has been able further to show that these surface films possess, according to the conditions, the properties of solids, liquids, or gases, a fact of the greatest theoretical significance.

THE PROPERTIES OF MEMBRANES.

A joint discussion on "The Physical Chemistry of Membranes in Relation to Physiological Science" was held by the Chemistry and Physiology Sections, and was opened by Prof. H. E. Roaf. A membrane was defined as a structure separating two phases ; it might be semi-permeable or show permeability of varying grade, and the presence of the membrane made it necessary to consider the possibility of the occurrence of filtration, osmosis, electro-endosmosis, and other related phenomena, for the membrane limited diffusion and allowed differences of concentration of solutes on its two sides, giving rise to various osmotic and electrical phenomena. Physiology was largely concerned with the problem of the passage of material across physiological membranes : as example of these the lungs, intestine, kidney, and salivary gland might be taken.

In the lungs, there appeared to be no certain evidence that the membranes which had to be traversed by the gases entering and leaving the blood did anything but slightly hinder diffusion—the state of equilibrium between blood and air was almost attained, and oxygen never reached a higher partial pressure in the blood than in the air, nor did carbon dioxide ever have a greater pressure in the air of the alveoli than in the blood. Diffusion was adequate to explain not only the partial pressures found in blood and air, but also sufficed to account for the total amounts of oxygen and carbon dioxide traversing the membrane under all conditions.

The passage of substances across the membrane of the intestine offered a much more difficult problem, and one towards the solution of which we had made much less progress, for here many facts seemed to be in opposition to the view that mere diffusion was the chief or even an important factor. When the epithelium was removed from the mucosa of the small intestine, for example, absorption of its contents into the blood was slower, not quicker. Again, blood plasma could be absorbed completely from the lumen of the bowel into the blood, in spite of the apparent identity of the contents with the fluid part of the blood. Finally, when absorption took place from the bowel, the oxygen usage of the bowel had been stated to be increased, *i.e.* more work was being done by it under these conditions.

The kidney and the salivary gland presented equal difficulties ; that considerable work was done by the kidney in concentrating those blood constituents which were excreted, was indisputable. Similarly, the salivary glands could not act by any mere filtration, because, apart from the chemical differences between the blood and the saliva, there was the fact that the pressure reached in the salivary ducts when the flow was stopped by occlusion was, as Ludwig showed, much greater than the maximum arterial

pressure; one theory which had been advanced to explain this was that the secreting alveolus acted as an osmometer, and attracted fluid from the blood, but this theory leaves us still in somewhat of a dilemma. Some cells, such as the red blood corpuscles, appear to have membranes at their surfaces, but others do not; if an amœba be stained with an intra-vitam dye, the dye does not escape into the surrounding water when the surface of the amœba is punctured.

Prof. F. G. Donnan spoke of membranes from the physico-chemical aspect, but exhibited a good deal of sympathy and interest in the biological side of the question, which he described as one of the most important issues concerned with these physico-chemical studies. The fact that membranes might be living structures might alter all physico-chemical conceptions, particularly those based on the study of states of thermodynamic equilibrium. Living organisms utilised an environment not in such an equilibrium, were transformers and consumers of free energy, and environmental equilibrium meant non-activity and eventual death. Energy potentials might run up in one place and down in another, so that interpretations would be difficult. After referring to the thermodynamic aspect of osmotic pressure, Prof. Donnan reviewed some of the theories which had been advanced in explanation of the properties of membranes. The sieve theory, according to which a semi-permeable membrane acted merely as a sieve, was rather discredited: some form of adsorption theory seemed more attractive; for example, if a substance is negatively adsorbed, it will be repelled from the walls of the pore, so that pure solvent alone passes through. As a modification of this we have various views of ionic adsorption which are capable of explaining many facts. The formation of a Helmholtz double layer on the walls of the pore would explain why the mobility of one ion can be reduced more than that of the other. Different concentrations of electrolyte on the two sides, or a different mobility of ions, would cause a flow by producing electro-endosmosis. The alteration effected in liquid-liquid potentials when a membrane was interposed might also be explained on similar lines. (A separate paper contributed to the discussion by Dr. E. B. R. Prideaux also dealt with membrane potentials considered as diffusion potentials.) The product of the activities of two ions on either side of a membrane permeable to both were the same—this is the explanation of the facts of membrane equilibrium (Donnan equilibrium), and is of considerable importance to physiology. The explanation of differential permeability, as given by Meyer and Overton, was that one of the constituents was soluble in the substance of the membrane, while the other was not; this view is not acceptable to physical chemists. Also, the suggestion of Clowes, that the reversal of phase in a membrane of emulsoid structure might explain a changed permeability of membranes, cannot be entertained.

Science and Social Service.

THE presidential address delivered by Sir George H. Knibbs at the New Zealand meeting of the Australasian Association for the Advancement of Science in January 1923, entitled "Science and its Service to Man," reviews the recent advances in the fields of astronomy, relativity, atomistics, radioactivity, spectroscopy, and various branches of chemistry, including biochemistry, metallurgical chemistry, and a number of technical applications of synthetic chemistry. There is a brief notice of the Rutherford-Bohr theory of atomic structure, and the properties of colloids and of vitamins are discussed, together with the functions of the ductless glands, and their relation to human development. The following extracts from the address are of particular interest:

The highest product of civilisation is not the mere maintenance of man on the planet, but such maintenance as makes him a student of that vast universe of which physically he forms so utterly insignificant a part—a student, developing faculties by means of which he can appreciate beauty, magnificence, majesty, and, indeed, the whole range of things spiritually apperceived or intellectually grasped—a student capable of solving the most apparently hopeless problems.

Nevertheless, in addition to these intellectual gifts, the proper study of science may result in important material advantages. At the same time it must be recognised that scientific advance has introduced previously unsuspected dangers; and while it is essential that nations which desire to preserve their independence should study the application of science to warfare, the terrible weapons which modern discovery places in the hands of unscrupulous nations, and the devastating nature of modern warfare, cause one to tremble for the future history of mankind if means cannot be found to eliminate the evil. Vital statistics clearly show that, with the present normal rate of growth of populations, the world will, in a comparatively short period, become incapable of supporting its teeming millions, in spite of the possibilities of increasing the productivity of the soil.

The overspill of dense populations provokes situations from which apparently there is no escape, for it involves agreement as to expansion, and the much-discussed question of birth control has to be seriously considered. A review of the whole realm of Nature warns us that there *may* be no way of escaping the great issue. May it not be then accepted that, as long as human nature is what it is now, war is certain, even if it be not inevitable. The way *could* come in peace, but only through a world-wide discipline, vastly more thoroughgoing than any discipline we dream of at present.

The address concludes with a plea for the creation of a national appreciation of science, for improvement of scientific education, and for the development of research.

"Our hope is to see a new spirit born here. No one knows what lies on the knees of the gods. But there is something within the mind and heart of any great people which responds to the dream of excellence, and inflames when the vision of national destiny is before it. Our Mother-land has had a great past. Is its offspring here in southern seas, illumined by 'the gem pointed cross and the blazing pomp of Orion,' to rise to material, to intellectual, and to moral greatness among earth's peoples? If so, the path is strenuous, but glorious. All visions of ease and luxury are but opiates, and lead to destruction. We shall need to gird ourselves for the task, and create for ourselves a world where our sons, knowing something of the splendid mysteries of the boundless universe, and also of our own little world, will excel in the art of using to the full the heritage our nation has given us. Then indeed will science have rendered noble service to the sons of Australasia."

The Frenophone.

A NOVEL form of telephone receiver, called the Frenophone (Fig. 1), the invention of Mr. S. G. Brown, has been exhibited recently at the Royal Society conversaziones and at the Exhibition of Scientific Apparatus held in connexion with the British Association meeting at Liverpool. Its chief feature is the amplification of weak signals to great loudness without loss of purity in the rendering. It is thus of especial value in wireless telephony, such as broadcasting, where singing and orchestral music must be faithfully reproduced without the sort of distortion associated with inferior gramophones.

This novel "loud speaker" depends for its operation upon the high degree of friction existing between a moving surface of optical glass and a pad of cork

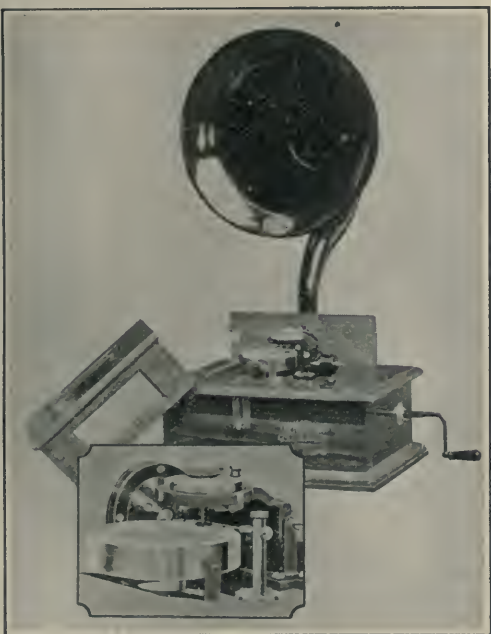

FIG. 1.—The Frenophone. Inset, enlarged view of the revolving glass disk with cork friction pad.

or similar substance. The coefficient of friction, especially when the glass surface has been lightly treated with a tacky compound, is so high that very slight changes in a constantly applied pressure between the pad and glass produce enormous fluctuations in the tangential drag between them.

In practice, the glass surface is made in the form of a disk revolved slowly by a gramophone clock. The pad consists of a small steel disk faced with thin cork. The pad is laid upon the glass, its back being pressed upon by a light, flexible pin which, in turn, is fastened to the reed of a Brown telephone headpiece receiver. The pad is linked by "reins" to the diaphragm, which is of the usual loud-speaker type, and is fixed at the base of a trumpet.

Speech currents in the receiver coils actuate the reed, setting it in vibration. These vibrations, imparted to the pad, appear as oscillatory changes of the steady pressure of the pad on the glass disk. Corresponding large changes of the pull of the pad, by its reins, upon the diaphragm result in great amplification of the speech emitted from the trumpet. The great merit of the instrument, as compared with other forms of loud speaker, is the combination of loudness with purity; the sounds of the various musical instruments are individualised with absolute fidelity to the original.

University and Educational Intelligence.

BELFAST.—Mr. R. W. Livingstone has been appointed vice-chancellor of the Queen's University. Mr. Livingstone, who is tutor and librarian of Corpus Christi College, Oxford, is the author of various publications in defence of classical education.

CAMBRIDGE.—Mr. E. W. Rice, junior, honorary chairman of the General Electric Company, Schenectady, New York, has sent on behalf of his board of directors "a check for five thousand dollars" to Sir Ernest Rutherford, to use to advance the work over which he presides. The gift to the Cavendish Laboratory is in appreciation of the debt which the General Electric Company owes to the Cavendish professor and his co-workers in scientific research. Mr. H. C. Levis, chairman of the British Thomson-Houston Company, has sent a cheque for 250*l.* for a similar purpose. These gifts will be used to supplement existing resources for research in the Cavendish Laboratory.

Mr. M. Dixon, Emmanuel College, has been appointed senior demonstrator in biochemistry.

GLASGOW.—The subject for the essays to be sent in competition for the Thomson prize in geography for the session 1923–4 is "Dwellings in Lands of Equatorial Climate: their Types, Materials, and Geographical Distribution." The competition is restricted to matriculated students of the university for the session 1923–4. The latest date for the receipt of essays is October 20, 1924. Each essay must be distinguished by two mottoes, accompanied by a sealed letter bearing on the outside the same mottoes, and containing a declaration subscribed by the author that the essay is entirely his own. They should be sent to the Clerk of the Senate.

LONDON.—Mr. Geoffrey E. Duveen has given the sum of 10,000*l.* for the establishment of a University lectureship in otology.

The title of reader in plant ecology has been conferred on Dr. E. J. Salisbury of University College.

The following doctorates have been conferred: *D.Sc. in Chemistry:* Mr. R. Ray (University College), for a thesis entitled "Studies on Boron and Silica"; and E. W. J. Mardles, for a thesis entitled "A Contribution to the Theory of Colloidal Chemistry based on Studies in the Colloidal Chemistry of Cellulose Derivatives," and other papers. *D.Sc. in Physics:* Mr. H. P. Waran (University College), for a thesis entitled "Disintegration in Discharge Tubes." *D.Sc. (Economics):* Mr. H. Finer (London School of Economics), for a thesis entitled "Representative Government, and a Parliament of Industry."

MANCHESTER.—The following are among the persons on whom the new chancellor, the Earl of Crawford and Balcarres, will confer honorary degrees on the occasion of his installation on November 10: Mr. J. G. Adami, vice-chancellor of the University of Liverpool, Sir James G. Frazer, Sir Arthur Keith, and Sir Thomas H. Warren.

OXFORD.—By the recent death of Dr. A. Rambaut, the post of Radcliffe observer becomes vacant. It was in memory of Manuel Johnson, one of Dr. Rambaut's predecessors, that the Johnson memorial prize was founded. This prize is usually offered every four years for an essay on some astronomical or meteorological subject. It has been awarded this year to G. M. B. Dobson, Lincoln College.

The Burdett-Coutts scholarship in geology has been awarded to L. F. A. Edgell, University College.

The Halley lecture for 1924 will be delivered by Prof. John Joly, professor of geology and mineralogy, Trinity College, Dublin.

THE University of King's College, Windsor, Nova Scotia, is to be moved to Halifax. A large part of its buildings was destroyed by fire in 1920, and its work has since been carried on with much difficulty in cramped and uncomfortable quarters. The Carnegie Corporation of New York will make a large grant towards the expenses of re-establishing the college at Halifax, where its work will be carried on in association with the University of Dalhousie. Its engineering courses will be discontinued.

IN accordance with the terms of the will of the late Sir Archibald Dawnay, the Royal Institute of British Architects has awarded one scholarship of 50*l.* per annum to Mr. R. W. Donaldson (University of Liverpool), and two scholarships of 25*l.* per annum each to Mr. R. H. Turner (University of Liverpool) and Mr. A. E. Cameron (Architectural Association). Mr. C. H. Hutton (University of Liverpool), who was awarded a scholarship of 25*l.* for 1922–1923, has been granted a renewal of his scholarship for 1923–1924. The scholarships are intended to foster the advanced study of construction and the improvement generally of constructional methods and materials and their influence on design.

A PRIZE fellowship of 1000 Swedish kronor, offered for research in science by the Swedish Federation of University Women, has been awarded to an Englishwoman, Mrs. Muriel Wheldale Onslow. Mrs. Onslow is distinguished for her work on the biochemistry of plants. She has already been an "N" Fellow of Newnham College, Cambridge, and in 1915 was awarded a fellowship of the British Federation of University Women. The Swedish award proves that the work of British women in science is noteworthy not only in Great Britain but also in competition with that of other scientific workers, for the fellowship was open to the university women of eighteen countries.

A LIST of qualifications for teachers in technical schools recognised by the Burnham Committee for salary purposes as equivalent to a degree has been approved by the Board of Education, and has recently been issued as Appendix III. to the Report of the Standing Joint Committee on Salaries for Teachers in Technical Schools. (H.M. Stationery Office: Imperial House, Kingsway, London, W.C.2. 1*d.* net. By post, 1½*d.*) In Section (*c*) Science and Technology the following qualifications are accepted:—(i.) *Academic Qualifications:* Associate of the Royal College of Science, London or Ireland, of the City and Guilds of London Institute, or of the Royal School of Mines; (ii.) *Membership of Professional Societies:* Associate membership of the Institutions of Civil Engineers, Mechanical Engineers, or Electrical Engineers, provided that the Associate Membership Examination has been passed, and that three years' engineering experience after the age of 21 is reckoned as part of the qualification; associateship of the Institute of Chemistry, provided that the Institute's Examination for Associateship has been passed; and membership of the Pharmaceutical Society and Pharmaceutical Chemist, provided that the Qualifying and Major Examinations have been passed, and followed by three years' professional experience; (iii.) *Miscellaneous:* Whitworth scholarship if gained between 1887 and 1922; and the first-class Colliery Managers' Certificate if the holder has three years' industrial experience after the age of 21, and has also obtained the diploma of a recognised mining college. This list may be modified from time to time, and qualifications not included can be submitted to the Board of Education by Local Authorities for approval.

Societies and Academies.

PARIS.

Academy of Sciences, October 8.—M. Albin Haller in the chair.—A. **Lacroix**: Notice on P. Elie Colin. The greater part of Colin's life was spent in Madagascar, where his work in geodesy, meteorology, and magnetism formed the foundation of all subsequent work in these subjects in the island.—Jean **Perrin**: Radio-chemistry of fluorescence. The theory developed in an earlier communication is modified to agree with the observation that in certain cases the fluorescent body may enter into chemical combination with the solvent (glycerol) or with oxygen. The influence of temperature on photo-chemical reactions is also investigated.—Ch. **Depéret**, F. **Arcelin**, and L. **Mayet**: The discovery of fossil remains of man of the Aurignacian age at Solutré (Saône-et-Loire). Three complete skeletons were discovered in positions which definitely prove burial. Drawings of the three skulls, with descriptions, are given. The men belonged to the Cro-Magnon race, Aurignacian period, but differ in some respects from the Cro-Magnons of Vézère and Grimaldi.—Alex. **Véronnet**: The formation of planetary systems and stellar systems.—R. **Fortrat** and P. **Dejean**: An attempt to construct a bobbin without iron giving intense magnetic fields. The solenoid was constructed of wires of electrolytic copper, rectangular in section, cooled by a rapid current of water. The apparatus as made could carry a current of 4740 amperes and absorbed 277 kilowatts. A field of more than 40,000 gauss was obtainable.—Louis **de Broglie**: Quanta, the kinetic theory of gases and Fermat's principle.—L. P. **Clerc**: A question of photographic perspective.—Albert **Portevin**: Remarks concerning the relation between Young's modulus and the atomic volume. The equation expressing the relation between Young's modulus, the density and the atomic mass given in a recent communication by Th. Peczalski is identical with results arrived at by Fesserden in 1892. There is approximate agreement between the formula and experiment for certain metals, but for others, notably rhodium, tantalum, and tungsten, there are wide discrepancies, tungsten, for example, giving 42·2 as the modulus against 8·0 calculated.—P. **Vaillant**: The influence of small variations of temperature on the conductivity of solid salts and the rôle of the humidity in this phenomenon. The results of the experiments described lead to the conclusion that in solid salts the electrical conductivity is largely superficial and due to a particular condition of the surface layer. This accounts for the marked influence of traces of moisture on the observed conductivities.—V. **Sorrel**: Polarisation capacities with alternating currents.—Marc **Bridel**: Biochemical study on the composition of *Monotropa hypopitys*. Isolation of a new methyl salicylate glucoside, monotropitine. The extracts of this plant contain two glucosides, monotropeine and monotropitine, the latter being new: they are readily separated by their different solubilities in acetic ester. The new glucoside, monotropitine, has been isolated in the pure, crystalline state. Some physical and chemical properties are given: it does not appear to be identical with gaultherine.—René **Wurmser**: Energy yield and chlorophyll assimilation.—A. **Maige**: Remarks concerning the formation and digestion of starch in plant cells. The theory best in accord with known facts on the formation and digestion of starch in plants consists in regarding these two phenomena as due to entirely distinct catalytic actions.—G. **Truffaut**

and N. **Bezssonoff**: The influence of the sugar concentration of the media on the activity of nitrogen fixing bacteriă. Both for the development of the aerobic bacilli in a non-nitrogenous medium and for the fixation of nitrogen in those possessing this property, low sugar concentrations of the order of 1 in 1000 are more advantageous than those usually employed.—M. **Lemoigne**: The butyleneglycollic fermentation of calcium lactate by bacteria of the *B. subtilis* group. The formation of 2-3-butyleneglycol and acetylmethylcarbinol by the action of bacteria of the *B. subtilis* group on calcium lactate has been proved. The action is slow and difficult to detect.—H. **Barthélémy**: The action of water, common salt, sodium bromide, and calcium chloride on the spermatozoids of *Rana fusca* and *Bufo vulgaris*.—A. **Weber**: Does the rupture of the branchial operculum at the moment of metamorphosis of Batrachians demonstrate the transmission of an acquired character?

VIENNA.

Academy of Science, July 12.—R. Wettstein, president, in the chair.—Fritz **Früchtl**: A contribution to the knowledge of the qualitative and quantitative distribution of Copepoda in the Plankton of the North Adriatic and of their ectoparasites. The use of graphic representation in distribution-maps.—Gerhard **Kirsch** and Hans **Pettersson**: On the destruction of atoms by α-particles. A study of the H-particles produced when atoms are destroyed by swift α-particles. The ranges of the atomic fragments (H-particles) are 18 cm. for beryllium, 12 cm. for silicon, 13 cm. for magnesium in air. The ratio between the H-particles produced and the number of α-particles employed is about 10^{-5} for beryllium, 6×10^{-6} for silicon and magnesium.—J. **Hepperger**: On the heliocentric velocity of meteors. Theoretical representation of the relative numbers of the frequency of meteors. Assuming the heliocentric velocity of the meteors to amount to 74 km. per second, the number of meteors per hour ascertained by observation may be made to agree with the relative numbers.—Julius **Zellner**: Contributions to comparative phytochemistry. Chemical analysis of the leaves and flowers of *Knautia sylvatica*.—Konstantia **Püringer**: Chemical analysis of the leaves and flowers of *Chamænerion angustifolium*. Quantitative determinations show agreement in constitution for leaves and flowers.—Chaja **Feinberg**, Johann **Herrmann**, Leopoldine **Rögelsperger**, and Julius **Zellner**: Chemical analysis of the bark of *Acer campestre*, *Corylus Avellana*, and *Alnus incana*.—Josef **Einleger**, Jolanthe **Fischer**, and Julius **Zellner**: Chemistry of heterotrophic Phanerogamia. Loranthus was chemically analysed for the first time. Elements have been found in Viscum not previously recognised.—Hans **Przibram** (1): A critique of the transplantation experiments made by R. G. Harrison. The rudiments of the anterior limbs of axolotl embryos, if excised and implanted in the same or neighbouring situations upside down (with dorsal and ventral surfaces reversed), develop into extremities which have the symmetry of limbs belonging to the opposite side of the body. These experiments do not prove a change of the upper side of the rudiment into an under side by the influence of the body as a whole. It is an inversion of the polarity of the extremities, which grow proximally instead of distally. The inversely transplanted rudiment is impeded in the original direction of its growth by the adjacent parts of the body. (2) The causes of animal colouring. The presence of "dopa" (3, 4-dioxyphenylalanin) in the cocoons of night-butterflies and saw-flies causes spontaneous formation of melanine when water is admitted. While in the case of day-butterflies the sensitiveness to light of the tyrosinase-ferment plays a part in the adaptation to the brightness of the background, the adaptation of the night-butterflies is caused by the degree of moisture. The cocoons acquire a dark colouring on a moist, dark background.—Alfred **Ehrenpreis** (1): Curvature of the neck of the larva when the animal pole of the ovum of *Triton alpestris*, Laur., has been punctured. By puncturing the animal pole of fertilised, but still unsegmentated, ova of *Triton alpestris*, Laur., Przibram's hypothesis has been confirmed that the prospective signification of the animal half of the ovum is in the formation of dorsal parts of the embryo. An animal developed so far as to form a larva, after puncture had its head bent dorsally at almost a right angle, owing to a deep indentation in the neck due to the puncture. (2) Transplantation of the sperm of full-grown Urodelæ. Successful transplantation of the whole sperm of *Triton Cristatus*, Laur., by the autophorous method of Przibram. The transplanted spermatozoa were in good condition even four months after the operation; their functions were normal. The formation of the spermatophore was completed in eighteen days.—August **Jellinek** and Theodor **Koppanyi**: Mental capacity of rats with an injured brain. Kinæsthetic and optical experiments in training rats, the cortex of the cerebrum of which had been destroyed by thermo-cautery, proved that the associative memory of the rats is to a very large extent independent of the cortex of the cerebrum.—Sato **Kunio** and Leonore **Brecher**: The causes of animal colouring. In vertebrates it is probably the tyrosine in the teguments and dermal coverings that supplies the chromogen. "Dopa," as the element of pigment formation, could not be found in fish, birds, and mammălia.—Leonore **Brecher** and Ferdinand **Winkler**: The agreement of positive and negative "dopa"-reactions both in frozen sections and extracts. Frozen sections of rats' eyes, of the scalp of dark-haired men, of the chrysalis of *Vanessa urticæ*, and the cocoon *Bombix mori* did not show any "dopa" reaction; "dopa" was found, however, both in frozen sections of the cocoons of *Saturnia pavonia* and *Erigaster lanestris* and in their extracts.—Walter **Finkler**: (1) Reflex action to absence of moisture of the marsh toad, *Bombinator igneus*, Laur. On dry, clayey soil the toad remains stationary; the hind-legs only make an irregular alternating movement, which is a reflex action, probably in order to save itself from drying up and to get to the deeper, moister layers of earth. On dry ground the toads also lose the reflex of turning round. (2) The influence of external factors on the colour of the iris of marsh toads, *Bombinator igneus*, Laur. The golden colour of the iris of animals kept on moist ground or moss does not change. The iris of toads kept in aquaria becomes whitish when they are illuminated by a mirror from below; the iris acquires a green metallic lustre when the animal is kept on dry ground. When no light is admitted the iris does not change its colour. (3) Experimental variation of the colour of the skin of toads, *Bombinator igneus*, Laur., and *Bombinator pachypus*, Br. If the upland toad is kept on dry clay, light green spots appear on its back, resembling those of the marsh toad. Grey marsh toads turn green on moist clay; when kept in water and illuminated from beneath, a golden colouring with a metallic lustre appears on the two parotids, reminding one of the bronze metallic lustre of the ground-colour found in upland toads.

Official Publications Received.

Proceedings of the Royal Society of Edinburgh: Session 1922-1923. Vol. 43, Part 2, No. 16: The Sizes of Particles in certain Pelagic Deposits. By Miss A. Vibert Douglas. Pp. 219-225. Vol. 43, Part 3, No. 17: On the X-ray Corpuscular Emission from Iron in a Magnetised and Unmagnetised State. By Dr. G. A. Carse and D. Jack. Pp. 226-229. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 9d. each.

Transactions of the Royal Society of Edinburgh: Session 1922-1923. Vol. 53, Part 2, No. 20: Notes on Fossil Plants from the Old Red Sandstone of Scotland, I. Hicklingia Edwardi, K. and L. By Dr. R. Kidston and Dr. W. H. Lang. Pp. 405-407+1 plate. 1s. Vol. 53, Part 2, No. 21: On Palæopitys Milleri, M'Nab. By Dr. R. Kidston and Dr. W. H. Lang. Pp. 409-417+2 plates. 2s. (Edinburgh: R. Grant and Son; London: Williams and Norgate.)

Agricultural Research Institute, Pusa. Indigo Experiments, 1922. 1: The Effect on Produce when Vat Liquor is allowed to stand in the Beating Vat and Beating is delayed; 2: Effect of Neutralizing the Liquor with Caustic Soda before Beating. By J. H. Walton. (Indigo Publication No. 12.) Pp. 8. (Calcutta: Government Printing Office.) 4 annas.

Government of India. Department of Industries and Labour: Public Works Branch. Irrigation in India: Review for 1921-1922. Pp. iv+27. (Calcutta: Government Printing Office.) 6 annas.

Memoirs of the Indian Meteorological Department. Vol. 24, Part 4: Correlation in Seasonal Variations of Weather, VIII. A Study of World-Weather. By Dr. Gilbert T. Walker. Pp. 75-131. (Calcutta: Government Printing Office.) 2 rupees.

Diary of Societies.

MONDAY, NOVEMBER 5.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion: Turbulence in Tidal Motions: Prof. J. Proudman, G. I. Taylor, and Dr. H. Jeffreys (Chairman, Dr. H. Lamb).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Monthly Meeting.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—W. Lee: Lubrication.

INSTITUTE OF TRANSPORT (Annual General Meeting) (at Institution of Electrical Engineers), at 5.30.—T. Salkield: A Transport Adventure in Persia.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—Dr. A. Russell and others: Discussions on Engineering Training.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. T. P. Nunn: Scientific Objects and Common-Sense Things (Presidential Address).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. G. W. Monier-Williams: The Use of Hydrogen Cyanide for the Fumigation of Ships.

ROYAL INSTITUTE OF BRITISH ARCHITECTS (at 1 Wimpole Street), at 8.30.—Presidential Address.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Col. J. C. B. Statham: From Mossamedes to the Victoria Falls.

TUESDAY, NOVEMBER 6.

INSTITUTE OF HYGIENE, at 3.30.—Dr. J. Fenton: Preservatives and Adulterants in Foods.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. J. Singer: The History of Anatomy (FitzPatrick Lectures) (1).

MINERALOGICAL SOCIETY (at Geological Society of London) (Anniversary), at 5.30.—Dr. L. J. Spencer: Euclase and Platinum from Diamond Washings in British Guiana.—H. E. Buckley: The Anomalous Optical Properties of Freshly Prepared Mixed Crystals of Seignette Salt.—Col. N. T. Belaiew: The Genesis of Widmanstätten Structure in Meteorites and Terrestrial Alloys.—Prof. L. R. Wilberforce: Illustration and Detection of Inclined and Horizontal Dispersion in Bi-axial Crystals.—A. Russell: The Occurrence of the Rare Mineral Nadorite in Cornwall, and of Beraunite (Eleonorite) in Co. Cork, Ireland.—A. F. Hallimond and F. R. Ennos: Moravite from North Wales.—Dr. G. T. Prior: The Chemical Composition of the Ashdon Meteorite.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—F. A. Mitchell-Hedges: The Primeval Jungle of Panama.—G. H. Goldfinch: Notes on the African Crested Rat (*Lophiomys imhausi*).—H. G. Jackson: A Revision of the Isopod Genus *Ligidium* Brandt (Crustacea).—I. G. S. Montagu: Some Mammals from Jugo-Slavia.—I. G. S. Montagu and Grace Pickford: The Guernsey *Crocidura*.—Major S. S. Flower: Additions to the Snake Fauna of Egypt.—S. Hirst: Some New or Little-known Species of Acari.—Dr. C. F. Sonntag: The Pelvic Muscles and Generative Organs of the Male Chimpanzee.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Sir Charles Langbridge Morgan: Presidential Inaugural Address and presentation of Medals.

INSTITUTION OF MARINE ENGINEERS, INC., at 6.30.—R. J. McLeod and T. Calderwood: Gear Cutting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. D. Johnston: Presidential Address.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss M. A. Murray: Excavations in Malta.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Sir Oliver J. Lodge: X-rays and the Atom (Presidential Address).

WEDNESDAY, NOVEMBER 7.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—The late R. W. Hooley: The Skeleton of *Iguanodon atherfieldensis* sp. nov., from the Wealden Shales of Atherfield (Isle of Wight) (read by Dr. A. Smith Woodward).—Prof. S. H. Reynolds: The Igneous Rocks of the Tortworth Inlier.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—E. H. Shaughnessy: Chairman's Inaugural Address.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS, INC. (at Engineers' Club, Coventry Street), at 7.—F. G. Whipp: Some Common Faults in Fan Design and Application.

ENTOMOLOGICAL SOCIETY OF LONDON, at 7.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—D. Rattonji Nanji and W. S. Shaw: A Quantitative Study of the Limitations of the Reaction between Ammonia and Sodium.—Phyllis H. Price: The Gold-Beaters' Skin Test for Tannins.—W. Donovan: Determination of Nitrogen in Coal.—J. C. Thresh: The Estimation of Lead in Water and Urine.

ROYAL SOCIETY OF ARTS, at 8.—Lord Askwith: Exhibitions.

THURSDAY, NOVEMBER 8.

ROYAL SOCIETY, at 4.30.—A. S. Parkes: Studies on the Sex-ratio and Related Phenomena—Fœtal Retrogression in Mice.—R. A. Fisher: The Influence of Rainfall on the Yield of Wheat.—(To be read in title only.) D. Thursby-Pelham: The Placentation of *Hyrax capensis*.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. J. Singer: The History of Anatomy. (FitzPatrick Lectures) (2).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—W. G. Spencer: Melanosis (Melanin, Melanoma, Melanotic Cancer) (Bradshaw Lecture).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. Jessie White: Auto-Education.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Dr. J. H. Jeans: Van der Waals Memorial Lecture.

INSTITUTE OF METALS (London Local Section) (at Royal School of Mines), at 8.—Dr. W. Rosenhain; Some Impressions of American Non-ferrous Metallurgy.

FRIDAY, NOVEMBER 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Dr. J. H. Jeans: The Mechanism and Structure of Planetary Nebulæ.—S. R. Pike: The Development of Faint Images by Fogging.—W. M. Smart: The Proper Motion of a Faint Star near η Cassiopeiæ.—B. Lindblad: The Intensity-Distribution in Short Grating Spectra and Objective-Prism Spectra as a Function of Spectral Type and Absolute Magnitude.—R. Stoneley: The Elastic Yielding of the Earth.—Sir George Greenhill: The Time or Mean Anomaly in a Newton-Einstein Orbit and Allied Astronomical Problems.—W. F. Denning: (*a*) Stationary Meteors and Meteors nearly Stationary observed at Bristol since 1879; (*b*) Radiant Points of Meteors, 1912-1923.—W. S. Franks: The Relation between Visual Star Colours and Spectral Classes.—F. H. Seares: A Troublesome Systematic Error.—Roy. Obs. Greenwich: Mean Areas and Heliographic Latitudes of Sunspots in the year 1922.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Dr. A. Ferguson: The Measurement of the Surface Tension of a Small Quantity of Liquid.—Prof. A. L. Narayan: The Scattering of Light by Carbon Dioxide, Nitrous Oxide, and some Organic Vapours.—Sir Richard Paget, Bart.: A Demonstration of Experiments with Models for the Reproduction of Vowel Sounds.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Sir Alexander C. Houston: The Application of Photography to the Problems affecting Water Supply.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Dr. C. E. K. Mees: Amateur Cinematography.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. C. A. Raisin: Volcanoes.

MONDAY, NOVEMBER 5.

UNIVERSITY COLLEGE, at 5.—J. W. Jeaffreson: The Analysis of Stress-Accent by the Methods of Experimental Phonetics.

VICTORIA LEAGUE (at 22 Eccleston Square), at 5.—Lt.-Col. M. C. Nangle: Burma.

TUESDAY, NOVEMBER 6.

UNIVERSITY COLLEGE, at 5.30.—J. H. Helweg: Daily Life in the XVIth Century as depicted by the Historian, Troels-Lund. (Succeeding Lectures on November 13, 20, 27, December 4 and 11.)

WEDNESDAY, NOVEMBER 7.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—W. A. Bullough: Problems of Health Science in Rural Districts.

UNIVERSITY COLLEGE, at 5.30.—J. C. Gröndahl: The Work of Henrik Wergeland: Creation and Man. (Succeeding Lectures on November 14, 21, 28, December 5 and 12.)

THURSDAY, NOVEMBER 8.

GUY'S HOSPITAL MEDICAL SCHOOL, at 5.30.—Prof. E. W. Hey Groves: The Treatment of Injuries of the Long Bones produced by Accident or Disease. (Succeeding Lectures on November 9, 12, and 13.)

UNIVERSITY COLLEGE, at 5.30.—Chevalier T. Sambucetti: Italy and Europe (League of Nations Union Lecture.)

FRIDAY, NOVEMBER 9.

UNIVERSITY COLLEGE, at 5.15.—Prof. J. C. Drummond: Vitamins.

KING'S COLLEGE, LONDON, at 5.30.—C. E. M. Joad: The Philosophical Background of Music and Poetry: (1) The Function of Poetry.

UNIVERSITY COLLEGE, at 5.30.—R. H. Hooker: The Effect of the Weather on the Crops (Jevons Memorial Lectures). (Succeeding Lectures on November 16, 23, and 30.)

ROYAL SOCIETY OF ARTS, at 8.—Major H. Barnes: Hygiene and Architecture: (1) Preventive Hygiene: Health and Town-Planning (Chadwick Lectures).

SATURDAY, NOVEMBER 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. S. Harrison: Fashion among Savages.

NATURE

SATURDAY, NOVEMBER 10, 1923.

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The Imperial Institute and the Development of Overseas Resources.

THE Imperial Economic Conference has approved a scheme whereby the Imperial Institute is to be reconstituted; a representative of the Department of Scientific and Industrial Research is to be one of a committee of three appointed to see that the Institute laboratories limit their work to preliminary inquiries, and the Galleries are to be closed, in spite of the protest of New Zealand, on the score of economy. The detailed account which has just been issued by the Imperial Institute (Bulletin of the Imperial Institute, vol. xxi., No. 1, pp. iv + 289, price 3*s*. 6*d*.) of its work in recent years has been published at a very convenient time. The Institute was founded in 1887, but until 1903 the work for which it was established was subordinated to the effort to run it as a social club attached to a ballet. It was reorganised in 1903, and in that year it began the publication of its quarterly Bulletin, which now has a circulation of 3000 copies, and also issued the first report by its Mineral Surveys. Its efforts then to undertake the work for which it was founded were handicapped by restrictions, burdens, and prejudices inherited from the former regime. The Institute has, however, been steadily surmounting these difficulties and building up an organisation by which to help the utilisation of the varied materials still lying unused in the Empire Overseas. It works by three main branches. Its Department of Scientific and Technical Research investigates all kinds of raw materials and advises as to their profitable employment. Its Intelligence Department gives information and advice, and is aided by committees of commercial, technical, and scientific experts, which deal with raw materials, silk production, rubber research, timber, and the mineral resources of the Empire. The extensive museum attractively displays the chief raw materials and illustrates the geographical conditions under which they are produced and the processes by which they are utilised.

The work already achieved by the Institute is clearly of high value. The discovery of the Udi coalfield by one of its Mineral Surveys would alone repay all the expenditure on the Institute; for that coalfield, in the event of any serious war in north-west Africa, would be invaluable in the defence of our colonies there, and it will probably develop into a coaling station of high importance from its position on the tropical Atlantic. The discovery of the monazite sands of Ceylon has destroyed the former German monopoly based on Brazilian material. Several of the Mineral Surveys organised by the Institute have now passed away from it, as they have developed into independent geological surveys.

As to other natural products, investigations in the

Institute laboratories or carried on elsewhere have removed from Indian beeswax the suspicion of adulteration that had arisen owing to its varied natural composition. The Institute has helped to render tobacco one of the chief crops of Nyasaland. It has shown why Indian barley to be serviceable for malting must be shipped from Calcutta by May and from Bombay by June. It has further helped India and the medical world by destroying the former monopolies held by Russia in santonin and by Germany in thymol. It has shown that for many purposes the kapok of India can be used instead of that yielded by a different tree from Java. It has assisted British Africa and the tanning industry by showing the value of the sant seeds of the Sudan and by finding British markets for South African wattle. Its work on the commercial production of acetophenone in Western Australia promises useful results. It has shown, in spite of the general view to the contrary, that Indian opium often contains a sufficiently high proportion of morphine and codeine to replace the supplies of Turkey and Persia which failed during the War. It has aided tea and rubber cultivation in Ceylon, and the Sudan by recognition of the special qualities of its gums. It has helped to improve the cocoa of West Africa and develop its palm oil production. It has secured the offer to Palestine of higher prices for Eri silk than those paid for the material elsewhere. It has shown that the *Croton Elliottianus* of Kenya Colony yields a valuable drug, and that the Indian aconites include several medicinal reagents, the production of which would be profitable to India and useful in medical practice. It has given helpful advice in fibre and bean production in East Africa, in wood pulp manufacture in Canada, and in connexion with the minerals, timbers, and drug-producing materials of Australia and New Zealand.

The Institute has been helpful not only by encouraging production, but also by avoidance of waste and disappointment in premature attempts to utilise materials in areas which cannot at present compete with more favourably situated localities. Meanwhile it collects information as to the position of such materials, so that they can be reconsidered from time to time as the conditions alter.

The work in the Exhibition Galleries of the Institute is not the least important of its services. The Imperial Conference has directed attention to the need for improved geographical education as regards the Empire. We referred in an article (April 1, 1922, p. 403) to the Public Exhibition Galleries of the Institute as "without question the finest illustration of economic geography in the world." All the chief materials of the Empire are shown there with ingenious illustrations of the volume of output, their distribution throughout the Empire, and the geographical conditions under which they occur. Important geographical features are illustrated by models, such as those of the Victoria Falls and of important harbours; ethnographical factors by models of different races; the scenery of different regions by pictures and photographs; local handicrafts by collections of work; and Oriental artistic culture by decorated pavilions such as those of India and Ceylon. Statues of Cook and Raffles direct attention to great landmarks in historical geography.

In addition to the public galleries there are research collections for reference by industrial experts and commercial inquirers. The galleries are unique as the only centre at which may be seen the opportunities and resources of all parts of the Overseas Empire. Although closed on Sundays, the galleries have 100,000 visitors a year and 10,000 school children go in classes under the guidance of their teachers and the Institute's lecturer. The loss of these galleries would be educationally deplorable.

The organisation of the Institute has proved well suited to its work. It is managed by an executive council, including representatives of the contributing states and colonies, with the Under Secretary of State for the Colonies as the chairman. This arrangement secures widespread but voluntary association, and the Institute organisation may prove a useful model on which still greater experiments in Imperial co-operation may be made.

That the Institute supplies a widely-felt need is shown by the numerous inquiries sent to it from all parts of the Empire. In 1922 it returned in replies no less than 1334 reports. The chief subjects, in order of number, were tropical agriculture, minerals, fibres, oils and oil-seeds, food-stuffs and fodders, timbers, drugs, and paper-making materials. That the information given by the Institute is of use to our larger Dominions as well as the smaller colonies is indicated by the widespread origin of the inquiries. They included in 1922, 121 from India, 89 from Australia, 89 from South Africa, 52 from Kenya Colony, 45 from Nigeria, 37 each from Ceylon and the West Indies, 36 each from the Gold Coast and New Zealand, 35 from Canada, and a few from each of the smaller colonies and protectorates.

It may be hoped that the reconstitution of the Imperial Institute will extend its usefulness and enable it to carry to full success the main purpose for which it was founded. The development of the natural resources of the Empire would then be assisted by investigation into the economic biology, geology, and geography of the British Overseas Dominions through an institution worthy of the group of national scientific museums at South Kensington.

Field Natural History.

(1) *Hebridean Memories.* By Seton Gordon. Pp. xii + 180 + 65 plates. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1923.) 15s. net.

(2) *Shetland Pirates and other Wild Life Studies.* By Frances Pitt. Pp. 248 + 16 plates. (London: G. Allen and Unwin, Ltd., 1923.) 10s. 6d. net.

IT used to be said of leisured Englishmen that their first thought of a morning was—" What shall we kill to-day ? " but in the present generation there is a steadily increasing number of men and women who prefer patiently to study wild animals in their haunts and to learn as much as possible about their character and habits. Instantaneous photography has added greatly to the interest and permanent value of this form of field sport, and both the books before me owe much to the camera.

FIG. 1.—Cock and hen great black-backed gulls. The cock is the larger and is calling. From "Hebridean Memories."

(1) Mr. Seton Gordon's field-studies have been conducted chiefly in the Highlands and Western Islands, where land and water retain much of their primitive aspect and still harbour creatures that have long been exiled from the low country. The hen-harrier—*Circus cyaneus*—for example, though practically extinct as a resident in the mainland, still rears its young in the Western Isles, although even there its survival is precarious. " It seems," says Mr. Gordon, " to be only a question of time before this handsome bird shares the fate of the kite and the white-tailed eagle, for even to its most inaccessible [least accessible ?] nesting grounds collectors make their way every year, and to a collector a clutch of hen-harrier's eggs is a prize of the first order."

Happily Mr. Gordon has something to set against this gloomy forecast. Until three years ago, the whooper swan—*Cygnus musicus*—had not been known to nest in Great Britain since the end of the eighteenth century; but on a certain loch which must remain, like the clan Macgregor, "nameless by day," a pair of whoopers reared their young in 1918 and 1919, and in 1920 two pairs nested there. " One nest," says the author, " is still intact as I write; the other has been robbed by collectors." As Christians we are bidden to love our enemies, but as sinful mortals it is something far removed from a blessing that we invoke upon these nefarious thieves. Unless vigorous measures are taken to protect the nests, we shall lose this splendid bird once more, owing to the perverse curiosity of a few armchair naturalists who will give ten times the price for a British-laid egg of a whooper than he will pay for one laid in Iceland.

Mr. Gordon pitched his tent—an inconspicuous one, no doubt—about fifteen feet from the whooper's nest,

and succeeded in getting some excellent photographs. He always entered the hide accompanied by his wife, who presently left it, rowing away from the island.

"It is useless to enter any hiding-tent unless one is accompanied by a companion, and unless that companion departs as ostentatiously as possible. All birds

Fig. 2.—The wild cat—expressions of the emotions.
1. Sulky. 2. Angry. 3. Furious.
From "Shetland Pirates and other Wild Life Studies."

can count *one*, but very few more than one; so a human figure leaving their nest stills their suspicions and causes them to return without delay, provided they have become accustomed to the presence of the hiding-tent, which should, if possible, be erected a few days previously."

Beasts as well as birds came under the author's scrutiny. The incident of a rabbit pursuing and driving away a stoat reminds me how, one summer evening, a large rat was driven close to my feet by a rabbit—presumably a doe protecting her young—was seized and severely shaken, and limped away squealing.

It surprises one that Mr. Gordon, who is at pains to defend the character of merlins, ravens and other birds of ravin, should repeat without comment what one would fain to be calumny against the dipper—*Cinclus aquaticus*. "It is said to do much harm when the sea-trout are spawning" (p. 51). We have the authority of the late Prof. Newton to the effect that "innumerable examinations of the contents of its stomach have not only proved that the charge [of devouring the ova of fishes] is baseless, but that the bird clears off many of the worst enemies of the precious product."

Mr. Gordon takes good note of the plants that grow in the waste places which he loves. The rose-root is recorded correctly as *Sedum rhodiola* on p. 21, and under the obsolete title *Rhodiola rosea* on p. 56. The illustrations throughout are admirable. The black-backed gulls, most ruthless of marauders, seem as harmless as doves in Fig. 1.

(2) The title of Miss Frances Pitt's volume "Shetland Pirates" is reminiscent of Magnus Troil and his daughters Minna and Brenda, but it is of feathered pirates only that she has to tell, namely, the great skua or bonxie—*Stercorarius skua*—and Richardson's skua or scootie—*S. parasiticus*. No doubt they live mainly by piracy, harrying gulls so cruelly that these have to disgorge their catch, and robbing the nests of other birds; but Miss Pitt charitably thinks that both species do occasionally fish honestly on their own account. These rapacious birds are described in the first chapter; each of the remaining chapters recording the author's observation of other birds and beasts, both in captivity and in the wild. She tells us how she used to declare that "there was no animal so wild that it could not be tamed by patience and kindness"; but her experience with a true wild cat—*Felis silvestris*—which she received as a kitten from Inverness-shire brought her to a different opinion, namely, that none of that species can be tamed or trained (Fig. 2).

One of Miss Pitt's most charming chapters deals with stoats and weasels; but I feel unable to share her doubts about the purpose of the white winter pelage assumed by both these little carnivores in northern regions, and by the stoat in parts of Great Britain. She cites the black tag on the stoat's tail as evidence against that purpose being protective coloration; but it is surely not more conspicuous than the white scut in the general protective colour of a rabbit. Miss Pitt's suggestion that a white coat better enables an animal to endure cold than a dark one receives no

support from the arctic fauna, for while the land mammals in polar regions are white in their snowy environment, the pelagic mammals — whales, seals, walrus, etc.—remain dark. The polar bear, hugest of Ursidæ, would encounter far more difficulty in stalking seals—his favourite food—were it not for his white mantle.

Miss Pitt has undertaken useful analysis of the barn owl's bill of fare. In twenty-eight pelts or castings taken at random from the roosting-place of a barn owl, she identified the remains of 112 small mammals and 3 small birds. "In less than a month that owl had eaten 66 mice and rats and 46 shrews, a record that I suspect few cats could equal." A cat, it may be noted, might kill the shrews, but would not eat them, therein showing a discrimination which it were well that gardeners and others would observe between the beneficent insectivore Sorex and the destructive rodents Mus and Evotomus.

Fig. 3.—The British pine marten in full winter coat. From "Shetland Pirates and other Wild Life Studies."

Besides the experience gained through long hours of vigil in a hiding-tent, Miss Pitt has made still more intimate acquaintance with many wild animals, not as mere pets, but as free companions and messmates. Of these, the most intellectual were a pair of ravens, which spent much of their time "ragging" the cook alternately with her cat; the most docile was a merlin hawk, the most playful a pine marten (Fig. 3), which came as a "kitten" from the Cumberland Fells, and quite the most foolish and awkward was a brown hare. There is much entertainment, as well as sound information, in both these volumes.

Herbert Maxwell.

Earth and Sun.

Earth and Sun: an Hypothesis of Weather and Sunspots. By Ellsworth Huntington. With a Chapter by H. Helm Clayton. Pp. xxv+296. (New Haven: Yale University Press; London: Oxford University Press, 1923.) 23*s.* net.

FOR half a century or more, it has been known that the earth's magnetic condition varies in striking similarity with the state of activity on the sun's surface. Many attempts have been made to establish similar connexions between meteorological phenomena and the sunspot cycle, but only within recent years has it been possible to record indisputable success in such attempts. The element most clearly affected is, as might have been expected, the temperature. Köppen's work, supported by that of several other writers, demonstrates that at sunspot maximum the mean temperature of the atmosphere is slightly *less* than at sunspot minimum. The difference is small, being 0°·6 C. in the tropics, and falling to 0°·4 C. in temperate latitudes. It seems not unlikely that the diminution at sunspot maximum corresponds rather to increased terrestrial absorption—due to a greater amount of ozone in the upper atmosphere — than to diminished output of radiation from the sun. The sun sends out increased corpuscular emission, and almost certainly increased ultra-violet radiation, at times of sunspot maximum, so that it would be rather surprising were its total radiation to be diminished at such times. On the other hand, intensified short-wave radiation would probably produce more ozone, which would intercept a larger proportion of radiation on its way to the earth's surface.

Small as is this temperature variation, it may be expected to produce important effects upon other terrestrial phenomena. Such effects would show a connexion with the sunspot cycle, possibly almost as close as that shown by the temperature variation itself. Hence the fact that a meteorological phenomenon is strongly correlated with the solar activity does not necessarily imply that the connexion is direct and independent. It is doubtful whether any other independent solar meteorological effect has yet been established, though some remarkable secondary effects are known. For example, Mr. C. E. P. Brooks

has shown that the great African lakes, Victoria and Albert, show variations of level amounting to several feet, practically in synchronism with the sunspot curve, the maxima of the two curves occurring together. The rainfall in the drainage basins does not show a corresponding variation, and it seems probable that the high level at sunspot maximum is due to decreased evaporation owing to the lower air temperature. Again, Douglass has found several cases in which the growth of trees, as indicated by the thickness of their annual rings, has varied nearly in synchronism with the solar cycle; this is clearly an index of some more immediate solar meteorological effect, whether of thermal origin or not.

The question as to a possible influence of solar activity on the barometric pressure is one which has received considerable attention. In the case of this element the solar effects must necessarily be more complicated than in the case of temperature, where the variations are likely to be everywhere of the same sign at a given time, though with local differences of magnitude. The total atmospheric pressure upon the earth can scarcely be appreciably affected by the sun's changes, so that if the solar influence increases the pressure in one region, there must be a countervailing change in other regions. The difficulty of detecting such effects is clearly much greater than that of demonstrating the temperature changes—itself an exacting task. Any such barometric changes which occur appear to be small, and must be obtained by averaging the results from a number of stations; if these happen to be distributed across the borders of oppositely-affected regions, the effect sought for may almost or quite cancel out; in any case it requires extremely detailed research to establish changes of particular sign in different regions, and to ascertain the limits of these regions.

Such investigations have of late years been prosecuted vigorously, and not without valuable results, by a number of American meteorologists—amongst others—and are recorded by Mr. Ellsworth Huntington in his new book. The sub-title of this work is "An hypothesis of weather and sunspots"; it is a companion volume to his recent book on "Climatic Changes," which dealt mainly with past relationships between the earth and sun, while the present work is concerned with existing connexions. The leading idea of both books is that terrestrial meteorology depends partly on purely terrestrial conditions, and partly on changes in the solar activity; the latter "are supposed to act chiefly through variations in barometric pressure and especially in the number, location, and intensity of cyclonic storms." It is also claimed that there is an important solar-activity effect on atmospheric electricity. The elucidation of such questions as these is obviously a matter of great interest and significance, and it is very convenient to have a summary of the present state of knowledge of the subject set out as is done in this book. The author has himself devoted enormous labour to this kind of investigation, and writes both with enthusiasm and with a wide acquaintance with the literature concerned. But to the reviewer it seems that much more evidence is required before it is safe to accept many of the conclusions which the author regards as established. In particular, the evidence for any regular effect of solar activity on barometric pressure and atmospheric electricity seems inadequate. There seems, however, to be a case for a connexion between sunspots and cyclones in certain tropical regions.

A considerable section of Mr. Huntington's book is devoted to the inverse problem of planetary influence upon solar activity. Mr. H. Helm Clayton contributes one of the four chapters in this section, and it is rather surprising to see in this chapter what seems to be an error elsewhere expressly pointed out by Mr. Huntington, namely, that the tidal influence of the planets on the sun is inversely proportional to the square of the distance of the planet from the sun. Many attempts have been made to relate the sunspot variations to planetary periods, but with doubtful success. The period of Jupiter (11·86 years) is not very different from the mean sunspot period (11·2 years), but the discrepancy is sufficient to render it very problematical whether any relationship between the two can be credited, even when allowance is made for the disturbing influence of the other planets. Mr. Huntington puts forward a hypothesis of electrical influence by the planets upon the solar atmosphere, but at present this is almost purely speculative. Such questions may be easier to decide when the nature of sunspots is better understood than now. At the moment it is at least a possible view that the main sunspot variation is due to some intrinsic solar period. S. C.

Biology and Sociology.

Essays of a Biologist. By Julian Huxley. Pp. xv + 306. (London: Chatto and Windus, 1923.) 7*s.* 6*d.* net.

THIS brilliant book, though somewhat disfigured by overlapping and repetition in certain parts, is one of the most suggestive and enlightening works for the popularisation of science which have appeared for a long time. It covers a wide field, and Mr. Huxley shows himself in it a man of wide interests, many parts, and an easy and attractive style of writing. He has two serious articles, covering much the same ground, on a new rationalistic conception of God; a sound

and careful survey of the relations of biology and sociology; a charming essay, full of careful observation, on the manifestation of emotion in birds; a light satirical discourse called "Philosophic Ants" on the relativity of our conceptions, two admirable discussions on sex psychology and on the biological approach to progress, and last, but not least, seven sonnets introductory to each chapter. They are quite good sonnets too.

It would be impossible in a short review to give any idea of the varied contents, and it would spoil the reader's enjoyment to pick out the plums too freely. But one may indicate the author's attitude on the more important topics of which he treats. The last two papers contain his attempted rationalistic reconstruction of the idea of God, being an analysis and elaboration of the statement that "the conception of God always represents man's idea of the powers operating in the universe." It will be noticed that the second of these papers, delivered at Woodbrooke at the sixth of the Unity History Schools, approaches more nearly, on the side of divine personality and of communal religion, to the ordinary attitude of the Churches.

It is not to be supposed that Mr. Huxley weakens anywhere in his allegiance to positive science. He tells us in the first paper that a "law of Nature is not something revealed as absolute, not something imposed on phenomena from without or from above; it is no more and no less than a summing-up, in generalised form, of our own observations of phenomena." He adopts, in fact, entirely in this matter the position which Dr. E. W. Hobson has been illustrating so fully in his recent Gifford Lectures. Students of Comte will note with interest that "the sciences are a hierarchy, the subject-matter of one constituting the foundation for the next in the series." The relation of biology to sociology is elaborated more than once in the book as an illustration of this. Sociology subsumes all the conclusions of the lower or earlier sciences, and adds to them various new considerations, or laws, of its own. With man in fact there has been a "radical change in evolutionary method" due to his power of transmitting the results of abstract reasoning by collective tradition.

Many readers will find the chapter on "Bird-Mind"—"Ils n'ont que de l'âme"—the most delightful thing in the book. The account of the egrets' honeymoon in Louisiana is almost too good to be true. Apparently they sit side by side for hours together with their long necks intertwined in a true-lovers' knot.

Mr. Huxley is right, after all, in giving the first place in the book to the essay on progress, which puts the doctrine so usefully and convincingly from the point of view of the biologist. It was certainly a serious omission, as he points out, to have had no chapter on this aspect of the subject in "Progress and History." We can see the human facts so much more clearly as they arise from the common biological evolution of universal life. From this point of view progress is seen to consist in "an increase in the control exerted by organisms over their environment, and in their independence with regard to it"; in an increase in the harmony of the parts of organisms; in an increase in the psychical powers of willing, of feeling, and of knowing. In short, progress is the growth, in power and harmony, of the soul; and man, being the crown of animate existence, embodies the principles of progress most completely.

F. S. MARVIN.

The Petroleum Industry.

A Handbook of the Petroleum Industry. By Dr. D. T. Day, Editor-in-Chief. In 2 vols. Vol. 1. Pp. x+964. Vol. 2. Pp. vi+1006. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 2 vols. 3*l*. 15*s*. net.

THIS work, which might aptly be termed the "Redwood" of American petroleum literature, has been written with a very definite purpose in view, namely, as an aid to the best utilisation of oil and the development of new resources to offset the impending shortage of supply in the United States. In a striking preface the editor-in-chief, Dr. Day, discusses dispassionately the truth of a situation which many people, both in Great Britain and in America, seek to gloss over, usually from self-interested motives. Briefly the situation is this: there exist less than twenty years' resources of petroleum in the United States at the present rate of supply and demand. To this we may add that one-fifth of the total oil requirements of that country latterly has been derived from Mexico; but in Mexico also there has been a startling decline in output noticeable recently, due principally to salt-water encroachment in some of the most productive wells. Small wonder, then, that serious-minded Americans (and Europeans too, for that matter) are apprehensive of the future, and that the several specialists responsible for this handbook are actuated by a common motive, that of contributing "their special knowledge to this volume, in the hope that more oil may be found and better utilisation be given it."

Written expressly for the public, the work makes a more direct appeal to the engineers who produce and refine oil, and it may be said at once that the sections concerned with these aspects of the industry are by far the best. From the point of view of the general public, the enormity of detail, the size of the work (nearly 2000 pages of comparatively small type), and the impression

it conveys at first glance of being a highly technical treatise, will probably prove rather overwhelming, though it is to be hoped that these factors will not be detrimental to a wide circulation and thus defeat the main objects of its production.

The work is much more than a mere compilation. Fifteen specialists in different branches of the industry have contributed to its undertaking, and as a standard book of reference it thus stands alone. No one man, be he a Heaven-sent genius, can comprehend adequately the intricate ramifications of the oil-industry of to-day; no written work, the product of a single human brain, can possibly do justice to a subject the rapid evolution of which depends on progress along so many highly specialised branches of natural science.

Yet, like all things material, there are obvious disadvantages in the co-ordinated essays forming the substance of this work. Not the least of these is the strong American bias noted throughout; also the apparent lack of appreciation of problems which beset others than those engaged in the American petroleum industry. After all, though we readily admit United States supremacy if measured in terms of annual oil production, the Old World may surely claim a modest share in the research and invention which have contributed to the wonderful progress of petroleum technology within the last half-century. American industrial problems are not necessarily Eurasian, nor are American solutions to those problems necessarily final to foreign operators. Hence without for one moment casting any reflections on the high merit of the work, it seems to us that a far wider purpose (thus a correspondingly greater value) would have been served had the book been planned on a more broad-minded, international basis, with something more than passing mention of oil affairs external to the United States.

This international element, had it existed, would have balanced the detailed description of the stratigraphy, structures and oil occurrences of North America with something more than a few cursory paragraphs of similar Eurasian criteria, as given by Mr. F. G. Clapp, responsible for the first section on "The Occurrence of Petroleum." Mr. F. H. Lahee, in the second section on "Field Methods in Petroleum Geology," would have been compelled to demand (with great advantage to the section) more space to deal with methods applicable to other than simple phases of geological surveying. Mr. R. G. Smith would likewise have included some description of the impregnated sediments well-known in European industries in his section on "Asphalt," while Mr. D. E. Day's section on "Oil Shale" would have profited by some account of European occurrences and methods. Perhaps these, and similar omissions, will be remedied in future editions of the work; at all events most of the other sections are so good that it would be a pity if this were not done, thus making Day's "Petroleum Industry" a standard work in every sense of the word.

H. B. MILNER.

Our Bookshelf.

Friction. By Dr. T. E. Stanton. Pp. xiv+183. (London: Longmans, Green and Co., Ltd., 1923.) 12*s.* 6*d.* net.

IN recent years considerable advances have been made in our knowledge of lubrication, static friction, and the resistance exerted by fluids on bodies moving through them. The importance which this knowledge has for engineers can scarcely be overestimated, and it is fortunate that the man who has had the greatest share in making these advances has been able to find time to write a complete account of the whole subject.

In the term "friction," Dr. Stanton includes all the agencies by which the moving parts of a machine are retarded and their energy dissipated. First of these in importance comes fluid resistance, and the first chapter is devoted to viscosity, the physical property on which all fluid friction depends. The second chapter, on the "External Friction of Fluids," opens with an account of the application of Newton's principle of dynamical similarity to fluid friction, and the results of a wide range of experiments on the flow of fluids through pipes are discussed from this point of view. The remarkably wide scope of the discussion of the surface friction of fluids may be judged from the fact that the friction may be estimated from experiments on the flow of liquids or gases in pipes, from direct experiments, with sheets of metal exposed edgewise in the wind, from meteorological observations, from tidal data, and from observations of the velocity of the wind close to the surface of a flat plate. All these methods lead to nearly identical results.

Chapter iii. is devoted to the hydrodynamical theory of lubrication; recent work is summarised, and an interesting account is given of the mathematical considerations which led to the discovery of Mitchell's method of lubricating the thrust blocks of a steamer's propeller shaft.

It is perhaps to be regretted that the description of Hardy and Doubleday's recent researches on boundary lubrication has been compressed into one paragraph. The application of this work to engineering has not yet gone very far, but it seems probable that developments in that direction may be expected in the near future. The remaining chapters, on "Rolling Friction" and on "Friction and Heat Transmission," introduce problems about which little is known, but perhaps for that very reason they are as stimulating as any in the book.

The engineer will find useful information in every chapter, but it is to the physicist that the book makes its strongest appeal. It would be difficult to pick out from the whole range of physics a better example than the subject of friction affords of the interdependence of mathematical and experimental methods. The logical way in which the matter is arranged serves to emphasise this point of view.

G. I. T.

Real Mathematics: Intended Mainly for Practical Engineers, as an Aid to the Study and Comprehension of Mathematics. By E. G. Beck. (Oxford Technical Publications.) Pp. ix+306. (London: Henry Frowde and Hodder and Stoughton, 1922.) 15*s.* net.

ARE engineers as bad as they pretend to be, or, at any rate, as Mr. Beck wishes us to believe? His desire is "to bring about a change of attitude towards mathematics," "to show the thing as an actual, tangible reality, instead of as a collection of rigid and unrelated rules and formulæ." He asserts that "the physical realities of mathematics have become swathed about with wrappings of mystery and suggestions of the supernatural." No doubt there is still room for improvement in mathematical text-books; but Mr. Beck must be singularly ignorant of modern text-books if he imagines that these sentences are anything but a libel on them.

In any case, if modern mathematical text-books are at fault, their improvement will not be secured by Mr. Beck's methods. At bottom there seems to be nothing in his explanations that is not contained in most of the decent school books—only Mr. Beck talks a lot. In addition he says some absurd things. The most striking example is perhaps the discovery that $\sqrt{-25}=-5$.

Mr. Beck's views on mathematical teaching are best understood from the following self-revelation: "The ability to solve a differential equation is, of itself, not worth five seconds of effort to acquire; but if such ability enable a man to design machines or structures more economically, or if it serve him as a key to the recorded experience of others, its value would clearly be so enormous as to lie beyond the scope of ordinary means for estimation." In other words, the only justification of mathematics is the creation of dividends!

The Social and Political Ideas of some Great Mediæval Thinkers: a Series of Lectures delivered at King's College, University of London. Edited by Prof. F. J. C. Hearnshaw. Pp. 223. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1923.) 12*s.* 6*d.* net.

THIS volume contains eight studies of political thought in the Middle Ages which, with two exceptions, appear substantially in the form in which they were delivered as a course of public lectures in King's College, London, during the autumn of 1922. Seven of the lectures deal with individual thinkers, beginning with "Saint Augustine and the City of God," a composite production by the Rev. A. J. Carlyle and the editor, and one of the exceptions mentioned above, and ending with "John Wycliffe and Divine Dominion," also by the editor. It will be noted the term "Middle Ages" is, chronologically, if not theoretically, liberally interpreted. The remaining lectures deal with John of Salisbury (E. F. Jacob), St. Thomas Aquinas (Rev. F. Aveling), Dante (E. Sharwood Smith), Pierre Du Bois (Eileen E. Power), and Marsilio of Padua (J. W. Allen). The Principal of King's College contributes the introductory lecture, in which he draws an illuminating distinction between political theory and political thought, and fully justifies the claim for the interest of the subject to the modern reader who is not specially concerned with medievalism as a whole. The lectures cover the development of the idea of a national state out of the theory of an international organisation, spiritual or temporal, and are therefore not without bearing upon political theory of the present day.

Hunters of the Great North. By Vilhjalmur Stefansson. Pp. 288+16 plates+2 maps. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1923.) 7*s.* 6*d.* net.

IN this volume Mr. Stefansson recounts some of his early experiences in the Arctic when he was a member of the Leffingwell expedition in 1906–7. He tells of his travels with the Eskimo, how they taught him to hunt, to accept their diet and mode of life, to build snow houses and generally to live in comfort in a region which people will persist in regarding as inhospitable in the extreme. It is a volume of the lore of the Arctic full of vivid descriptions and personal incidents. The chapters on hunting contain a great deal of the natural history of the caribou, polar bear and seal, and there is of course much of interest regarding the Eskimo. Mr. Stefansson has given us no book of polar travel of greater interest than this volume. It should help to dispel some of the current fallacies regarding the Arctic climate and conditions of life in the far north. The call of the north is in its pages, which will awaken memories among those who know the ice, and stir others with a longing to go and see. R. N. R. B.

Mirrors, Prisms, and Lenses: a Text-book of Geometrical Optics. By Prof. James P. C. Southall. Enlarged and revised edition. Pp. xx+657. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.)

THE revised edition of Prof. Southall's text-book of geometrical optics, in addition to a number of new problems scattered throughout the book, contains an important new chapter at the end of the volume. The historical notes dealing with the rectilinear propagation of light, and optics in the seventeenth century are of considerable interest. It is usually stated that Newton was the first to distinguish seven colours in the prismatic spectrum, but Maurolycus (1575) in the explanation which he gave of the circular arc of the rainbow directs attention to the four principal colours, together with three other colours which he regarded as transitions. Reflection prisms are discussed at some length, and new and approved schemes of optical calculation, partly due to Mr. T. Smith, are described. A word of praise must be given to the diagrams.

Introduction to Practical Mathematics. By V. Seymour Bryant. Pp. 95. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 2*s.* 6*d.* net.

MR. BRYANT'S little book is intended to supply the needs of classes preparing pupils for the entrance scholarship examinations in science in Public Schools, and is based upon a syllabus issued by the Science Masters' Association at the request of the Joint Standing Committee of the Head Masters' Conference. The course suggested in the book is very suitable and interesting, and the explanations offered should prove of value to the pupils. S. B.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Relation between Solar Activity and Atmospheric Electricity.

DR. CHREE in his reply (NATURE, September 8, p. 361) to my communication on solar activity and atmospheric electricity (NATURE, August 11, p. 203) first makes reference to the status of the question as to the effect of sun-spot activity on the secular change of the earth's magnetism. Those who have investigated this question have reached apparently contrary conclusions according to the phenomenon examined, the data used, and the method employed by the individual investigator. It would require too much space to enter into detail as to the reasons for the discordant results. Let it suffice here to state that Dr. Chree and I have investigated different phenomena. Thus Dr. Chree, on the basis of the Kew data alone, concluded, contrary to Leyst, that the secular change of the *magnetic declination* did not vary markedly, if at all, with sun-spottedness.

Such a restricted investigation could, of course, not be accepted as settling the broad question as to whether any appreciable change in the *direction of magnetisation* of the earth may be related to solar activity changes during a sun-spot cycle. I, on the other hand, confined my investigation solely to the question whether there was an appreciable change in the earth's *intensity of magnetisation* which might be associated with change in solar activity during the sun-spot cycle. Instead of relying upon the data from one station alone, I used the intensity data from eight stations distributed around the globe, namely: Kew, Potsdam, Pola, Bombay (Colaba and Alibag), Honolulu, Sitka, Cheltenham (Maryland), and Porto Rico. Regarding the various questions which must be considered in investigations of this character, the interested reader may be referred to my paper on the subject,[1] at the conclusion of which the intention was stated of making a still more comprehensive examination, as soon as additional data were available.

With regard to the difference in the method or formula used by Dr. Chree and myself when investigating a possible relationship between solar activity and atmospheric electricity, let me state briefly the assumptions involved. Dr. Chree in his paper[2] adopts a formula which assumes that there is strict synchronism between the phenomena of sun-spottedness and atmospheric electricity, and that for the same sun-spot number, during the first and second halves of the cycle, for example, the atmospheric-electric element investigated should have precisely the same value. In my formula (NATURE, August 11, p. 203) I introduced a term, provisionally called a time- or cycle-term, which was intended to take into account, approximately, a possible a-cyclic effect in atmospheric electricity during a sun-spot cycle such that the atmospheric-electric element considered, barring other disturbing causes, would not have precisely the same value for the same sun-spottedness. With the aid of this additional assumption, which does not appear unreasonable in view of similar effects in other geophysical and cosmical phenomena, an improved mathematical representation was obtained and higher values of the correlation coefficient were derived than those which Dr. Chree had found. No futile attempt was made to get an *exact* representation by unduly multiplying the number of unknowns to be determined by the method of least squares. The desire was merely to obtain, in accordance with the best practice, a sufficiently satisfactory representation of the observed facts with the *fewest* possible unknowns; the general concordance in the derived unknowns from widely separated stations would appear to be ample justification of the formula employed.

It must be realised that no method of applying an a-cyclic correction, due to an undiscovered cause, can be made perfect; however, when more extensive data for several sun-spot cycles are available, no doubt improvements may be made. In this connexion it may be remarked that Dr. Chree's method of applying a-cyclic corrections to the observed magnetic and electric diurnal variations has not yet been generally adopted. However, no great refinement in mathematical method is requisite to show, even for the data at present available, that a definite relationship between solar activity and atmospheric electricity is sufficiently plausible to merit careful attention. Some of the evidences have already been cited in my previous communication and reference has been made to a later and more complete paper.[3]

Dr. Chree directs attention to some low values of the atmospheric potential-gradient at the Ebro Observatory; by reference to the observatory bulletins it will be found that recent low values, especially during the period June-October 1922, were not unnoticed by the Observatory, and that possible artificial disturbing causes were investigated, as the result of which some changes have been made. The Observatory will doubtless make such additional tests and redetermination of reduction factor as may be requisite in the circumstances. This later information from the Ebro Observatory had not been received at the time of my previous communication, in which data only to 1921 inclusive were utilised. (The date for No. 11 in Table 2 of my previous communication should be 1921·5, instead of 1921·1.)

I am glad that Dr. Chree is helping to keep alive an interest in the highly important question as to possible variations in atmospheric electricity which may have to be associated with changes in solar activity. We may rest assured that until this question is definitely settled no complete theory of the origin and maintenance of the earth's electric charge can be definitely formulated. My main purpose appears to have been accomplished, namely, to bring back into the literature a question for reinvestigation which was actively discussed more than a half-century ago and then dropped for want of sufficiently accurate data of the requisite extent. It is hoped that the renewed discussion will contribute towards the multiplication of atmospheric-electric stations where every possible care will be taken to ensure continuity of strictly comparable data for as long a period as possible. Among other precautionary measures, more frequent and more extensive controls, than is at times the case, of the factor for reducing observed potential-gradients to an infinite plane, are requisite.

LOUIS A. BAUER.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington,
October 5.

[1] *Terr. Mag. and Atmos. Elect.*, vol. 23 (1918), pp. 1-22 and 61-68.
[2] Proc. Phys. Soc., London, vol. 35, part 3, April 15, 1923, p. 132.
[3] It is expected that this paper may appear in the December, 1923, issue of *Terrestrial Magnetism and Atmospheric Electricity*, when it is hoped that, in addition to other data, those for 1922 at Kew and Eskdalemuir will be available.

Long-range Particles from Radium-active Deposit.

IN a letter to NATURE of September 22, p. 435, under this heading, L. F. Bates and J. Stanley Rogers suggest that the H-particles found by us (NATURE, September 15, p. 394) to become expelled from the atoms of Be, Mg, and Si, probably also of Li, by α-particles, are really identical with the long-range α-particles which these authors have obtained from radium C deposited on a brass disc. Highly interesting as their communication is, it does not, however, seem to have any direct bearing on our results.

The difference in brightness between the scintillations from α-particles and from H-particles viewed under identical conditions is so conspicuous, that no mistake is possible. Comparing the former to stars of the first magnitude, the latter would be of about the third magnitude; that is, a ratio in luminosity of about 6 to 1. By way of emphasising this difference we have, in the same scintilloscope, demonstrated the scintillations due to the H-particles from aluminium foil inside a glass capillary charged with emanation, together with the scintillations from polonium α-particles, before the physical section of Skandinaviska Naturforskaremötet, held in Gothenburg this summer. With due precautions the same experiment can also be carried out with a thin-walled silica capillary containing a few millicuries of emanation, so as to demonstrate the H-particles from silicon. Although there is very little doubt that the scintillations we have observed are really due to H-particles, an *experimentum crucis* can, of course, be made only by measuring their magnetic and electric deflection.

As was stated in our first communication, our final experiments were carried out with a minute emanation vessel divided into several communicating compartments of equal length, in which thin layers of different substances were spread over the bottom, made from thinnest copper foil. Control countings of the particles expelled from the naked copper foil of an empty compartment proved the number of these to be only a fraction of those expelled from the compartments charged with other substances. As the absorption curve for the "copper"-particles agreed with a theoretical absorption curve calculated for natural H-particles from hydrogen supposed to be occluded in the copper, there seems to be no reason for assuming them to be expelled directly from disintegrating atoms of radium C. But even if that were granted, there is no reason for ascribing that origin to the much more numerous particles of relatively short range expelled from the Be, Mg, and Si compartments of the same vessel, considering that the amount of emanation and its products present within each compartment was practically the same.

As a matter of fact a small number of scintillations of α-type was generally observed in our experiments, beside the much fainter H-scintillations, especially at the lowest values of absorption, when they were relatively numerous. We have so far not had occasion to examine these particles or their origin but have for the time being assumed them to be identical with the particles found by Sir Ernest Rutherford to be expelled from oxygen (*Phil. Mag.* vol. xxxvii. p. 562) which have in succession been taken for oxygen atoms carrying a single charge, double charged X nuclei, and now, apparently, α-particles of abnormally long range.

In conclusion, we may say that, judging from the experimental data at present available to us, we cannot see any other way of explaining the origin of the particles we have observed than by upholding our former view, namely that they are H-particles expelled at an artificial disintegration of the beryllium-, the magnesium-, and the silicum- (probably also the lithium-) atoms and not any long-range particles from radium-active deposit as the title given by the Editor to our first letter would seem to suggest. In that letter, in addition to the corrections pointed out in NATURE of October 13, p. 540, the word "neutral" should have been printed "natural."

GERHARD KIRSCH.
HANS PETTERSSON.

October 13.

Colour Vision and Colour Vision Theories.

WHETHER Prof. Peddie's explanations are adequate is a matter for the reader to decide. Let us take one of a fact which is conclusive evidence against the trichromatic theory. If the terminal portion of the red end of the spectrum be isolated in my spectrometer it will appear as a faint red upon a black background. If the eye be fatigued with red light, even by looking through a red glass held against a light for one second, the red will not be visible for some considerable time, but the eye may be fatigued for twenty minutes with yellow light without interfering with the visibility of the red light.

Prof. Peddie's explanation is as follows: "That there is no shortening at the red end of the spectrum after fatigue with yellow light follows at once if both the red and the green sensations are fatigued by the yellow light, while all three sensations, red, green, and blue, are present to some extent at all visible wave-lengths." But this explanation, which is inconsistent with the work of König, Abney, and others, does not explain why there is considerable shortening after slight fatigue with the red glass. Prof. Peddie does not explain Shelford Bidwell's crucial experiment, namely, that his red borders are not seen with spectral yellow light but are seen with a mixed yellow made up of red and green matching it.

As with other departments of science, the minutest accuracy is required in experiments on colour vision. Many results are due to impure colours and stray light. A chemist would not do Marsh's test for arsenic when he had bought his zinc at an ironmonger's and his sulphuric acid at an oil shop, both being contaminated with arsenic, but many workers are satisfied to use coloured papers for work on colour vision.

If the positive after-image of a spectrum be viewed it will be seen to disappear from the red to the violet end, and on the trichromatic theory it is stated that the positive effect of the red sensation disappears before that of the green; but in an absolutely dark room, if pure spectral yellow light be thrown on a white screen and a flicker apparatus rotated slowly in front of it, the yellow will not change its hue; on the trichromatic theory it should become green. The results are quite different when stray light is allowed to fall on the screen as well.

F. W. EDRIDGE-GREEN.

London, October 27.

Sex Chromosomes in Plants.

I HAVE recently been investigating the cytology of a number of diœcious plants with the intention, if possible, of throwing light on the matter of sex chromosomes in plants. Incidentally, I took up the genus Lychnis, one species of which, *Melandryum rubrum*, Garcke (*L. dioica*, L.), has been examined previously by Strasburger. In detailing his observations he states that, in both sexes, there are twelve pairs

of chromosomes present in the somatic cells. In the heterotype division he found one pair of bivalents much larger than the others, but the individual members of this pair were of equal size; thus no signs of the disparity indicating the possibility of two types of microspore were revealed.

I have examined its close ally, *Lychnis alba*, Mill., and find similarly twenty-four somatic chromosomes, of which two are larger than the rest. In the female plant at the reduction division these two appear similar; thus the daughter nuclei are alike. In the male, however, the two large chromosomes differ from one another both in size and shape; the larger one is bent, somewhat in the shape of a hockey stick, with the curved end pointing outwards from the spindle, whilst the smaller somewhat pear-shaped one is not more than two-thirds its size (Fig. 1). The shape is quite constant and the appearance is the more striking in that this pair of chromosomes takes the stain much more strongly than the others.

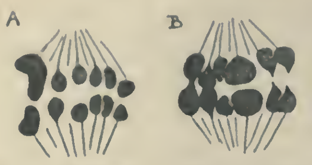

FIG. 1.—Heterotype division in *Lychnis alba*, Mill. A: male; B: female.

Since *L. alba* is so closely related to *L. dioica*, in which Shull has demonstrated sex-linked characters with the male heterozygous for sex, it seems more than probable that we have here a definite case of an XY pair of chromosomes in the male with a corresponding XX in the female. This is the first definite record of sex chromosomes in a Dicotyledon.

A full account of this and other species of Lychnis and their hybrids will be published shortly.

KATHLEEN BEVER BLACKBURN.
Botanical Department, Armstrong College,
Newcastle-upon-Tyne.

Powers of Perception of Birds.

MY attention has been directed to a note in NATURE of November 18, 1922 (vol. 110, p. 677), containing references to an article on "The Sense of Smell in Birds" (NATURE, June 17, 1922, p. 783), and to Dr. H. H. Beck's paper on "The Occult Senses in Birds" (*Auk*, 1920, xxxvii. 55). As your note intimates, there is evidence that neither by "occult sense" nor by smell do turkey vultures find their food. They certainly depend largely upon a very keen sense of sight, as is shown by the following incident.

A toy rabbit consisting of white plush and excelsior packing was given to our little girl a number of years ago. It proved to be a favourite toy. One night she forgot it and left it lying in the yard. As we sat at breakfast the next morning we were greatly surprised to see a turkey vulture strutting in a circle about the toy rabbit as it lay on the ground, and eyeing it with head turned to one side. Here was something new to his experience. It was certainly the form, but not the substance of a dead rabbit. If the turkey vulture has an "occult sense," in this case at least he did not depend upon it, or, doing so, was completely deceived.

The position of the writer of the note in NATURE is one to which we can subscribe when he says: "It is surely more reasonable to attribute these [powers of perception] to greater acuteness of the known senses than to imagine new senses for which no physiological basis can be suggested."

CHAS. W. PALMER.
Northeast High School, Philadelphia, Pa.,
October 15.

Population and Unemployment.

IN the résumé in NATURE of October 13 of the presidential address by Sir William Beveridge to the Economics Section of the British Association, the point which raised so much discussion in Liverpool is indicated by this sentence:—"Increased birth control is not required by anything in the condition of Europe before the War, and is irrelevant to our present troubles." As this idea has already been hailed by many, may I point out that Sir William entirely ignored the *unemployables*. Those who are unemployable through organic disease, feeble-mindedness, general debility, and various other characteristics of a "C 3" and physiologically inferior population do not appear in the ordinary list of unemployed, but they are, nevertheless, a huge financial burden on the community. Both a financial strain and a physiological danger to the race, they not only breed and reproduce their like if left without birth control; but they are brought into existence in otherwise healthy stocks whenever mothers under hard conditions reproduce too rapidly. Only by means of constructive birth control can women space their children so as to ensure the likelihood of reasonable health to those they bear under the modern and unnaturally hard conditions of slum life.

While Sir William Beveridge may play at ninepins with the primitive "Malthusian theory," it is most dangerous that, misled by his phrases, uncritical persons who confuse Malthusianism with constructive physiological birth control should be given such inopportune encouragement. Statistics confirm our common-sense observation that intelligent members of the better stocks are widely using birth control; hence, unless we do have an increase of birth control so that the inferior stocks also use it, we shall continue racially to deteriorate at an ever-accelerating speed.

MARIE C. STOPES,
President of the Society for Constructive Birth Control and Racial Progress.
7 John Street, Adelphi,
London, W.C.2.

A Possible Cure for Cancer.

WHILST reading Prof. Johnstone's remarks (Lancs. Sea-Fish. Lab. Report for 1922 (1923), p. 19) on malignant (cancerous) growths in fishes, I was struck by and seized upon the statement that "wen" is an example of a controlled growth.

So long ago as 1908 I remember Prof. Farmer suggesting in his lectures on "The Cell" that "cancer" might be due to lack of control of the individual as a whole over certain tissues, and this view has gained force ever since that time; but now arrives a statement that "wen" is a controlled growth. Let it be assumed that both statements are correct; then the individual with a wen contains or has contained in its system somewhere a controlling influence which—from many analogies—may not improbably exist in the blood. Now if wens occur in other suitable animals than man it would be an easy matter to extract plasma or other components of the blood for injection into other individuals of the same species having uncontrolled (cancerous) growths in order to test whether the controlling influence exists there and can be passed on to another individual.

If the suspicion were confirmed, a cure for cancer would be obtained, as the application of a similar process to man would no doubt follow very swiftly.

Or again, assuming that individuals with wens have an obvious control of a tendency to cancerous

growths, the suggestion is provoked that all normal mature individuals contain a factor—probably biochemical—which controls a tendency to abnormal growth. Why not then try simply the injection of blood-plasma or other constituents of the blood from normal mature individuals into cancerous subjects ?

It is of course possible that the factor inhibiting abnormal growth may lie dormant in the healthy individual or only occur at a particular phase of life—one of which may be at about the end of the growth period—and may not therefore be transmissible in blood constituents at all stages of the mature life-history, even supposing that the blood is the locus of the factor when it is active. A further possibility may be that only certain apparently normal individuals possess constantly an *active* growth-restricting factor and that these individuals remain to be identified. Whatever the importance of the above surmises may be, it would seem clear that the economy of individuals with "wens" must be regarded at present as of great importance in the study of cancerous growths. It is realised that there is a great deal of speculation in the remarks made above, but the importance of the subject is regarded as sufficient excuse.

J. H. ORTON.

Marine Biological Laboratory, Plymouth,
October 25.

Science and the State.

LORD SALISBURY has noticed with great pleasure your appreciative article (October 27, p. 609) on the co-operation of the different parts of the Empire in scientific research dealt with in his recent speech to the Imperial Economic Conference. He would like, however, to assure you and your readers that when he spoke of the willingness of scientific men to place their services at the disposal of the Government and the community for "far less than the true remuneration of their great talents," he was referring not to the scientific staff of the Department, but to the distinguished men who serve on the Advisory Council and other Committees and Boards of the Department, most of them entirely gratuitously. The members of the Advisory Council are offered a modest honorarium, but it is not always accepted.

PHILIP FARRER,
Private Secretary.

Privy Council Office, Whitehall,
October 30.

A Representative Scientific Council.

THE proposal made in the leading article in NATURE of October 13, page 529, seems of the utmost importance, and is therefore likely to be discussed by abler pens than mine. I venture, however, to touch on some considerations not yet covered by your opening statement.

In a world of disillusion, with Church and State both in discredit if not in disgrace, there is a widespread and keenly felt need for wiser guidance. Here is the opportunity. Some of us would say that in an age of revolutions, it is not a further enforcement of authority by the method of violence that is needed. To substitute the dictature of "Science" for the dictature of the proletariat is only to demonstrate that the real enemy is the bourgeois and the bureaucrat. Here is our temptation.

We have no recognised definition of scientific "truth" as distinct say from war truth, newspaper truth, or Quaker truth. Do we mean that our conclusions are always "contradictoire," open to challenge, verification, or correction ? If so, there is obviously no case for enforcing them on an ignorant but reluctant populace.

There is already some distrust of the learning of the medical profession. They are wise enough to be content to advise their patients, but not to enforce their advice. The Ministry of Agriculture is wise enough to issue advice. From the Board of Education we should welcome rather more advice and rather less administration. Just consider how much mischief might be done in the present state of our knowledge of eugenics by a new tyranny of good intentions and ignorance.

On the other hand, there is a very strong case for some public body of scientific experts which might advise and report on all matters affecting the public welfare ; for example, on the children of Russia, the reafforestation of Greece, the rebuilding of Tokyo, the finances of Germany, the frontiers of France. If some scientific (not political) body meeting in Geneva could find the right answers to these questions, some of us would be content to sacrifice all other sorts of authority vested in the League of Nations in favour of the authority that might ultimately accrue to an oracle which confined itself to good advice.

For the word "democracy" we might substitute "scientific initiative and democratic veto." We need both. Almost all that can be done by mass movements, like trades unions and armies, is to veto, to stop other things being done by other people. Initiative, doing new things, is generally the work of individuals, not of mobs. The case for a scientific advisory body is far stronger than any existing political system recognises. The House of Lords may be earmarked for the future development of Trades Unionism, but the Privy Council is an existing institution which could be developed into an acting advisory council, with no authority to enforce its advice.

It may be difficult to draw the line of representation among the claims of metaphysics, theology, theosophy, anthroposophy, anthropology, psychical research, and experimental psychology. An excluded minority of Christian Scientists might be hostile, as you say. Hence the virtue of Prof. Oppenheim's maxim :—"There will be voting and the majority will indeed decide, but that decision will only bind that majority. In matters of 'scientific' opinion are we not justified in saying that no majority however great should seek to enforce its decisions on any minority no matter how small ? "

On the other hand, consider the immense power that might be wielded by an advisory organisation that merely advised its members to "withhold support" from an existing political institution which seemed to be going astray. Imagine, for example, that during some recent wars the General Medical Council had advised its members to refuse service in all ambulance units or a Chemical Society disowning members engaged in manufacturing explosives, or a Trades Union refusing to make munitions or to accept Treasury notes in payment !

There is a little difficulty about registration. Is a university degree in science enough, or is research work necessary ? Or might the standard be lowered to the Preliminary Scientific Examination ; and what about people of quite obviously exploring habits of mind who have never had the chance of a university education ? The analogy of the Teachers' Registration Council a little suggests that registration might be the only aim which would be achieved.

The great thing is to maintain an offer of the best scientific advice available for the widest possible community.

HUGH RICHARDSON.

Wheelbirks, Stocksfield-on-Tyne,
October 23.

Radio Direction Finding by Reception.

THERE are in use to-day three principal systems of direction finding by which the apparent direction of arrival of a train of electromagnetic waves can be observed and, under suitable conditions, the direction of a radio transmitting station determined. These are usually described as the Bellini-Tosi system, the single frame system, and the Robinson system. The Bellini-Tosi system has been very fully developed by the Marconi Company for use on land and on board ship as an aid to navigation, and is the system most usually employed in this country for that purpose. The coil frame system has received most attention in the United States, and has there been the subject of a great amount of research work. The Robinson system, for reasons which will appear later, is specially suitable for use in connexion with direction finding in the air and has mainly been developed with that end in view. All three systems have been for the most part the subject of independent development and their several merits have been the subject of considerable controversy.

In general, however, all the systems operate upon the principle that the magnitude of the electromotive force induced in a vertical loop or coil of wire by an electromagnetic wave depends upon the angle between the plane of the loop and the wave front of the arriving wave. An electromagnetic wave can be considered as consisting of electric and magnetic forces which are at right angles to each other and to the direction of travel of the wave. These two force vectors are in phase with each other and each varies rapidly in a periodic manner. The effect on a wire placed in the field due to such a wave can be deduced from consideration of the effect of either the electric or the magnetic fields in the wave front. In the case of a single coil vertical loop of wire it can be shown that the periodic magnetic field due to an electromagnetic wave the wave front of which is plane, though not necessarily vertical, introduces in the loop an alternating electromotive force the maximum value of which is given by the following expression:—

$$E_m = \omega H_m A \cos \alpha$$

where ω is the periodicity of the wave, H_m the maximum value of the horizontal component of the magnetic field in the wave front, A the area of the loop, and $90° - \alpha$ the angle between the plane of the loop and the horizontal component of the magnetic field. The effect of the vertical component of the magnetic field may be disregarded since the plane of the loop is vertical and therefore cannot be linked by this component. If the loop is rotated so that the electromotive force becomes zero the plane of the loop is then parallel to the horizontal component of the magnetic field, and the direction whence the waves are travelling is thus at right angles to the plane of the loop. The direction of arrival of the waves can therefore be determined with an ambiguity of 180°. It can be shown that, in general particulars, the underlying principles of all the three systems in use to-day are the same—and that the systems are in their action essentially equivalent to the single rotating loop.

The single coil system most closely approximates to the simple theoretical case. A tuning condenser is, however, usually introduced in series with the coil across which the amplifying and detecting apparatus is connected; but it can be shown that the potential difference across this condenser depends on the orientation of the frame in the same manner as the electromotive force induced in the frame. The single coil, as used in practice, consists, as a rule, of several turns of wire instead of a single turn. These turns are usually spaced in a series of equally dimensioned loops in nearly parallel planes (box type coil), or are wound spirally in the same plane (pancake type coil). In the case of a pancake coil the quantity A in the expression given above is replaced by the effective or mean area of the coil. In the case of box type coil, since the winding of the coil is, of necessity, slightly askew to the axis of the coil, there is the possibility of an effective turn of wire being introduced the plane of which is practically at right angles to the main turns of the coil; the effect due to such a turn, however, introduces an error not exceeding 0·1°, which is negligible for all ordinary purposes.

The connexion of the tuning condenser and receiving apparatus to the coil introduces certain disturbing effects. First the electromotive force picked up by the leads and the whole circuit, although small compared with the maximum value of the potential difference across the tuning condenser, may be sufficiently strong to give an audible signal when the coil is orientated so as to make this potential difference zero (*i.e.* $\cos \alpha = 0$). In this way an ill-defined minimum may be produced, and accurate determination of the bearing made more difficult. Secondly, a bad zero may be produced by what is known as "vertical" or "antenna" effect. One side of the tuning condenser is connected to the grid of the first receiving valve, while the other side is connected to the filaments of the valves, to which in turn are connected the filament and anode batteries. The capacity to earth of the two sides of the coil joined to the tuning condenser will, therefore, in general be unequal, and a potential difference will be produced across this condenser even when there is no circulating current in the coil. One result is a blurring of the minimum, and another is that the two minimum positions are found on rotating the coil not to be exactly 180° apart, owing to the fact that the superimposed potentials due to the antenna action of the coil are nondirectional. These effects can be eliminated, however, by the introduction of a small variable balancing condenser between the grid of the first valve and the tuning condenser.

In the Bellini-Tosi system two large rectangular or triangular loops each of a single turn are erected with their planes at right angles. To each of these a small field coil is connected in series. These small coils are again mounted with their planes at right angles and between them is pivoted a small search coil, attached to which is a pointer which moves across a horizontal circular scale divided into degrees from which the observed bearings are read off.

The two field coils reproduce in miniature the field in which the main coils are placed, and the search coil turning within the small field coils is equivalent to

a single rotating coil directly receiving the energy of the waves. Thus the Bellini-Tosi system is in theory exactly equivalent to the ideal single turn rotating loop. The system, as in case of the single frame coil, is liable to a certain amount of "antenna" effect. It is also necessary in erection for care to be taken that the similarity of the two loops and their circuits is ensured, and that the planes of the loops are accurately at right angles.

In the Robinson system two coils, which differ as regards their area-turns, are fixed rigidly at right angles and pivoted about a vertical axis. The coils are connected in series and so arranged that the direction of winding of one of the coils can be reversed with regard to the other by means of a switch. In this way the electromotive force induced in the former coil can be added to or subtracted from that induced in the latter. When the coil with the larger area-turns is placed in the minimum position for signals induced by the arriving waves, the smaller coil is in the maximum position. In this position, on throwing over the switch from one position to another, no change of signal strength will be heard in the telephones attached to the receiving circuit, and the larger coil will be perpendicular to the direction of travel of the waves. Consideration of the theory of this system shows that the operation of the reversing switch is really equivalent to swinging a single frame, or the search coil in a Bellini-Tosi installation, through an angle on either side of the minimum position. The amount of this equivalent angle of swing depends on the ratio of the area-turns of the two coils of the Robinson system. This ratio is usually arranged so that for good sensitivity this equivalent angle is 20° to 30°.

Since, in using the system, the equivalent coil is swung to positions 20° to 30° on either side of the minimum by the action of the switch, the received signals are not reduced to zero intensity. The system is therefore suitable for use where the finding of the zero position is difficult through extraneous noises or interference, and it is, accordingly specially adaptable for use in aircraft.

All the three systems of direction finding are liable under certain conditions to errors which may be classed under three heads: (*a*) variable errors arising from causes influencing the direction of travel of the waves during their propagation through space, (*b*) errors due to the effect of the local surroundings of the receiving station, (*c*) instrumental errors.

A discussion of the three systems of direction finding as regards their basic principles and as regards their liability to the above three classes of errors has recently been published as Special Report [1] No. 1 of the Radio Research Board under the Department of Scientific and Industrial Research. The conclusion reached in this report based on a large number of careful observations is that each system is liable to errors of the same order of magnitude. The errors due to the location of the directional finder can be avoided, however, by careful selection of the site of the station, while instrumental errors can be reduced to practically negligible amounts by suitable design and arrangement of the apparatus. Until recently it appears to have been generally held that observations with undamped waves were more liable to error than those with damped waves. Experiment has shown, however, that the errors observed were occasioned by the heterodyne method of reception of undamped waves, and that they may be eliminated almost entirely by careful screening and arrangement of the heterodyne with regard to the receiving apparatus and aerial system.

The variable errors, falling under class (*a*), however, present much greater difficulty and so far no means of eliminating them have been found. Since they are introduced by changes in the direction of travel of the wave front during propagation the explanation of the factors which give rise to them is to be sought in the study of the propagation of waves. The fact that all the systems of direction finding are in their essentials equivalent to rotating the single turn rotating loop, is of great importance in this respect because in considering the effect of different wave fronts it is only necessary to consider the behaviour of the simplest type of aerial (*i.e.* the single coil type). The results of experiments carried out on one system then can safely be considered as applicable to the other two.

By any of the three methods discussed the direction of the horizontal component of the resultant magnetic field in the wave front can be determined. In practice, however, it is the direction of the horizontal component of the line of motion of the waves which is actually required. Should neither the direction of travel of the waves nor their resultant magnetic field be horizontal, then the setting of a coil in the minimum position for signal strength will have no necessary relation to the direction of arrival of the waves, and errors will be recorded by all three systems. On the other hand, provided the resultant magnetic field remains horizontal, the wave front may be inclined at any angle; or again, provided the wave front remains vertical, the resultant magnetic field may have any angle therein, without causing errors to occur in the observation of the direction. The variable errors are far greater by night than by day. The variation produced may arise very suddenly and the observed bearing may change at the rate of several degrees a minute, or the deviation in the bearing may remain steady for a considerable period. The magnitude of night variations, which are far greater than those due to location or to instrumental errors, may be judged from the following observations recorded in the Special Report of the Radio Research Board already referred to. In one series of experiments where observations were carried out with a Standard Robinson set and a portable type Bellini-Tosi set, erected in the same field at Slough, on various fixed transmitting stations employing waves between 2000 and 5000 metres, the maximum variation for Karlsburg observed with the Robinson set was 27·1° and with the Bellini-Tosi set 28°, for Moscow 9·9°, 9·2°, for Coltano 10·8° and 7·2° respectively. In another series of experiments, on waves of 2000 to 9000 metres, carried out at Orfordness with a permanent Bellini-Tosi apparatus and a standard Robinson set, the total variations at night ranged on various occasions from 5·0° to 54° for the Bellini-Tosi set and 5·2° to 51·3° for the Robinson set.

It should be remarked, however, that these large

[1] A discussion of the practical systems of Direction Finding by Reception, Dr. R. L. Smith Rose, and R. H. Barfield (Radio Research Board Special Report No. 1), published by H.M. Stationery Office. Price 9*d.* net.

variations occurred in cases where the distance between the transmitting and receiving station was great—being rarely less than 100 miles and in some cases as great as 1500 miles. Also the waves had travelled for considerable distances over land. These facts probably account for the changes in the apparent direction of travel of the wave front necessary to produce the large variations observed. Fortunately in the application of radio direction finding to navigation such conditions as a rule do not occur. Ships usually require their positions or bearings to be given when they are nearing land, and there is a considerable amount of evidence to show that, in the case of the shorter waves, as used by ships, passing entirely over sea for distances of the order of 50 to 80 miles, individual bearings very rarely show a maximum error of more than 5°, while simultaneous observations carried out on the same waves after passing over land frequently show variations of the order of 40°.

From the experimental evidence available it would seem that with a suitably situated shore direction finding station a ship at a distance of the order of 50 miles can be given a bearing, under normal conditions, with an accuracy to 1° to 2°. A single direction finding station can only give a ship her bearing from the receiving station, but if a second direction finding station suitably placed with respect to the first is available, two bearings can be given and the position of the ship can be fixed by their intersection. Experience has shown that such an intersection is usually sufficiently correct to enable a ship's position to be given with all the accuracy necessary for safe navigation.

O. F. B.

The Education of the People.[1]

By Prof. T. PERCY NUNN.

IN education, as in all the great fields of practice, there are, and must constantly arise, problems that can be solved only by patient application of the methods of science, but however far the scope of educational science may extend, the critical educational issues will always lie beyond it. For in its origin education is a biological process which does not wait for deliberation to call it into existence or for science to guide it, but has the inevitability of behaviour rooted in instinct.

What is it, then, that determines the general character of the educational process at a given point in the history of a human society? The answer is that the same *élan vital* which brought the society to that point urges it so to train its young that they may maintain its tradition and ways of life. It follows that the education a nation gives its children is, perhaps, the clearest expression of its *ethos* and the best epitome of its scheme of life. Thus the ideas of too many of our Georgian forefathers upon the education of the masses corresponded faithfully with their belief in the great principle of subordination about which Johnson and Boswell talked so often and agreed so satisfactorily. One remembers, for example, how hotly Miss Hannah More denied the scandalous rumour that she was teaching the poor of Cheddar to write! Similarly, the liberal curriculum of our elementary schools reflects the prevalence to-day of a widely different view of the nature and purpose of society. In brief, it is an expression of the steadily growing belief, first, that every member of society has an equal title to the privileges of citizenship; and, secondly, that the corporate strength of society should be exerted to secure for him actual as well as theoretical possession of his title.

How the movement based upon that belief will ultimately affect the happiness of our people no one can with certainty foresee; nevertheless, I am bound to record my opinion that in its main tendency it ought wholeheartedly to be accepted. I think this chiefly because it seems to be inspired by the Christian principle of the immense value of the individual life, or, if you prefer to put it so, by the Kantian principle that no man ought to be treated merely as a means but always also as an end in himself. But if the movement is accepted, public education must correspondingly assume a character which would follow neither from the principle of subordination nor from the principle of *laissez faire*. The view I submit is that the education of the people should aim at enabling every man to realise the greatest fullness of life of which he is by nature capable—"fullness" being, I add, measured in terms of quality rather than of quantity, by perfection of form rather than by amount of content. That view is the basis of all I have to say.

During the last century we learnt, following Darwin, to look upon all biological phenomena as incidents in a perpetual struggle wherein the prizes to be won or lost were the survival of the individual and the continuance of his species. From this point of view there could be only one object of life, one *causa vivendi*, namely, to continue living, and the means by which it was to be attained were adaptations to environment achieved by an individual, and perhaps handed on to its offspring, fortunate germinal variations, or lucky throws of the Mendelian dice. It was natural, if not logically necessary, that the doctrine should fuse with the view, as old as Descartes, that life is but an intricate complex of physico-chemical reactions. Upon that view, even to speak of a struggle for existence, is to use a metaphor admissible only on account of its picturesque vigour; when we study the forms, processes, and evolution of living beings we are spectators merely of the operation of physical and chemical laws in peculiar forms of matter.

These ideas, in either their more moderate or their more drastic form, affected the attitude of men towards matters lying far outside the special province of biology. National policies have been powerfully influenced by them, and it has been widely held that the education of children should be shaped mainly, if not solely, with the view of "efficiency" in the struggle for existence. It is, therefore, relevant to point out what tremendous difficulties are involved in their thorough-going

[1] From the presidential address delivered to Section L (Educational Science) of the British Association at Liverpool on September 14.

application. I will not speak of those which have driven physiologists of high standing to reject the mechanistic theory of life as unworkable, for they do not bear directly upon my argument. It will be more to our purpose to raise, as William James did in his great treatise on psychology, the question of the higher æsthetic, moral, and intellectual qualities and achievements of man, and to ask how these are to be brought under the conceptions before us. We will not press the question how the emergence, say, of Beethoven's Fifth Symphony is to be explained in terms of physics and chemistry; for even the most stalwart mechanists scarcely expect that it will actually be done; they only believe that conceivably it could be done. But it is both fair and necessary to ask how the things of which the symphony is typical can be accounted for on the principle of survival-value. James, facing this question with characteristic candour, felt bound to admit that they have "no zoological utility." He concluded, therefore, that the powers and sensibilities which make them possible must be accidents—that is, collateral consequences of a brain-structure evolved with reference not to them but only to the struggle for material existence. The premises granted, I do not see how the conclusion can be avoided; but surely it is extremely unacceptable. If, with Herbert Spencer, we could regard art merely as something wherewith to fill agreeably a leisure hour, we might be satisfied by the hypothesis that our sensibility to beauty in form, in colour, and in sound, is an "epi-phenomenon" having no significance in relation to the real business of life. But when we think of men whose art was in truth their life, and consider how eagerly the better part of mankind cherishes their memory and their works, it is next to impossible to be satisfied with that view. Take the case of science. Votaries of pure science often seek to justify their ways to the outer world by the argument that discoveries which seemed at first to have only theoretical interest have often disclosed immense practical utility. It is a sound enough argument to use to silence the Philistine, but would the pursuit of science lose any whit of its dignity and intrinsic value if it were untrue? I will not lengthen the argument by extending it to the saints and the philosophers, for its point should be sufficiently plain. The activities of "our higher æsthetic, intellectual, and moral life" have such intrinsic worth and importance that to regard their emergence as accidental and biologically meaningless is outrageously paradoxical. They must be at least of equal significance with anything else in man's life, and may not unreasonably be held to contain the clue to life's whole meaning.

It may be helpful to put the conclusion in other language. Man's life is a tissue of activities of which many are plainly *conservative* in nature, their function being directly or indirectly to maintain the existence of the race and the individual. Agriculture, industry, defence, medicine, are obvious examples of the type. But there are other activities—art and pure science are capital examples—the character of which is best indicated by the term *creative*. The point made is that in any sane view of human life as a whole the creative must be regarded as at least as significant and important as the conservative activities.

Purely conservative and purely creative activities, if indeed they exist, are only limiting instances; in most, if not in all activities, the two characters are interfused. For example, the motive of pure science is unmistakably creative, yet its extrinsic conservative value is unlimited; on the other hand, the vast industrial organisations of to-day exemplify activities which, though conservative in their genesis, yet have developed the creative character in an impressive degree. Considerations of this kind prepare one to see that the higher creative life, far from being merely a splendid accident, is really the clearest and purest expression of the essential character of life at all its levels. The poets are, as the Greeks called them, the supreme *makers*, for all making has in it something of the stuff of poetry. In short, there is no life, however humdrum, however crabbed by routine, which is not permeated by the self-same element, the inflorescence of which is literature, art, science, philosophy, religion.

The foregoing discussion has a close bearing upon the questions what should be taught and in what spirit the teaching should be given. The curriculum always *will* be a partial reflection of the actual life and traditions of a community, and *ought* to reflect all the elements therein which have the greatest and most permanent value and significance. Without doubt these will, in general, be the things that have the highest significance and value for the human family as a whole, but there can scarcely be said to be a common human tradition. There exists, it is true, a common European tradition based mainly upon the Græco-Roman and Christianity, and it is vastly important for the happiness of the world to deepen and vivify men's consciousness of it. But even this lacks the concreteness needed to form the basis of popular education. In short, a nation is the largest social unit whose *ethos* has the necessary individuality. Hence, though we should aim at making our young people "good Europeans," we can do so only by shaping them into that particular brand of good Europeans who are rightly to be called good Englishmen. Hence the importance of fostering in our elementary schools the special traits of the English character at its best; of giving English letters a chief place among the studies of our youth; of cherishing the English traditions in the arts and crafts, including our once proud art of music; even of reviving the old dances which were so gracious and typical an expression of our native gaiety and manners.

Lest this contention should be misunderstood, I add that I preach neither the hateful doctrine that what is foreign should, as such, be excluded, nor the ignorant and presumptuous doctrine that what is our own is necessarily the best, and that we have nothing to learn from other peoples. The whole burden of my argument is that the things which have universal human value are the things of most importance in education. But the universal can be apprehended only where it lives in concrete embodiments. In the cases we are concerned with, these are elements or organs of a national culture; and the only national culture to which a child has direct and intimate access is his own. He should be taught to see, as opportunity permits, how much of it is derived from the common European tradition and how much it owes to the influences of

other national cultures; but it should, in its concrete individuality, be the basis of his education.

Lastly, I have urged that among the strains or currents in a national tradition the highest value belongs to those that are richest in the creative element. These are themselves traditions of activity, practical, intellectual, æsthetic, moral, with a high degree of individuality and continuity, and they mark out the main lines in the development of the human spirit. Do we not rightly measure the quality of a civilisation by its activities in such directions as these? If so, must not such activities be typically represented in every education which offers the means to anything that can properly be called fullness of life?

If the force of the argument be admitted, the principles of the curriculum take a clear and simple shape. A school is a place where a child, with its endowment of sensibilities and powers, comes to be moulded by the traditions that have played the chief part in the evolution of the human spirit and have the greatest significance in the life of to-day. Here is the touchstone by which the claims of a subject for a place in the time-table can be infallibly tested. Does it represent one of the great movements of the human spirit, one of the major forms into which the creative impulses of man have been shaped and disciplined? If it does, then its admission cannot be contested. If it does not, it must be set aside; it may usefully be included in some special course of technical instruction, but is not qualified to be an element in the education of the people.

The same criterion may be applied to the methods by which the subjects of the curriculum are taught. We are constantly told that the "educational value" of a subject lies in the mental discipline it affords, and, from this point of view, a distinction is made between its educational value and its import as an activity in the greater world; thus geometry is taught as a training in logic, the use of tools as "hand and eye training," and so forth. From the point of view I adopt that distinction is unjustifiable and may be dangerously misleading; it has, I fear, often been a source of aridity and unfruitfulness in school teaching. The mistake consists in supposing that the disciplinary value can be separated from the concrete historical character of the subject as a stream of cultural tradition. The discipline of the school workshop consists in using the tools of the craftsman for purposes cognate with his and inspired by his achievements. Similarly the discipline of school geometry consists in steeping one's mind in a certain noble tradition of intellectual activity and in gradually acquiring the interests, mental habits, and outlook that belong to it. To say this is not to minimise the importance of discipline or to expel from school studies the austerity which the grave old word suggests. What is insisted on is that the several forms of mental discipline are characters of concrete types of creative activity, practical, æsthetic, intellectual, and that they influence the mind of the learner favourably only in so far as he pursues those activities as adventures of the human spirit, laborious yet joyous and satisfying, and pursues them after the manner of the great masters. In short, true discipline comes simply by trying to do fine things in the fine way.

The foregoing principles are open to misconceptions against which it is desirable to protect them. In the first place, it may seem that I am designing the education of the people upon a scale which may be magnificent but is certainly impracticable. It is easy, no doubt, to form extravagant expectations, and by seeking to do too much to achieve nothing solid at all. But the argument is concerned far less with the standard to which school studies may be pursued than with their proper qualities and the spirit that should inspire them. In particular, it is directed against the attitude expressed recently by a public speaker who asked what good is poetry to a lad who will spend his days in following the plough and spreading manure upon the fields. Against this attitude it urges that a man's education, whatever his economic destiny, should bring him into fruitful contact with the finer elements of the human tradition, those that have been and remain essential to the value and true dignity of civilisation.

It may be objected, granted the soundness of the ideal, that the shortness of school life makes it impracticable. It is true that a study, to be of real value, must be carried far enough and followed long enough to make a definite and lasting impression. It is also true that some studies can scarcely produce their proper effects until a certain level of maturity has been reached. But what is to be deduced from these admissions? Surely the conclusion, which the public mind is slowly accepting, that so long as children leave school for good at fourteen some of the best fruits of education will be unattainable and the security of the others precarious. It is not merely a question of length of time, but also, and even mainly, of psychological development. The more carefully youth is studied the more significant for after-life the experience during the years of adolescence is seen to be. Its importance is not a modern discovery; for even the primitive races knew it, and the historic Churches have always taken account of it in their teaching and discipline. The case for universal education beyond the age of fourteen depends ultimately upon the importance of shaping the new capabilities of the adolescent in conformity with the finer traditions of civilised life. Public opinion, regretting the generous gesture of 1918, has not at the moment accepted the larger view of the mission of education; but as the nation learns to care more for the quality of its common manhood and womanhood and understands more clearly the conditions upon which that quality depends, the forward movement, now unhappily arrested, will certainly be resumed. For that better time we must prepare and build.

There is another objection to which I should think it unseemly to refer if it were not a stumbling-block to so many persons of good will. A liberal public education will, they fear, make people unwilling to do much of the world's work which, though disagreeable, must still be carried on. The common sense of Dr. Johnson gave the proper reply a hundred and fifty years ago. Being asked whether the establishment of a school on his friend Bennet Langton's estate would not tend to make the people less industrious, "No, sir," said Johnson, "while learning to read and write is a distinction, the few who have that distinction may be the less inclined to work; but when everybody learns to read and write it is no longer a distinction. A man

who has a laced waistcoat is too fine a man to work; but if everybody had laced waistcoats, we should have people working in laced waistcoats."

Lastly, the ironical may ask whether it is an error to suppose that the education of the people should furnish them with useful knowledge and abilities. Now the test of utility which the plain man applies to education is, in principle, sound and indispensable: the only point doubtful is whether the test is always based upon a sufficiently broad idea of utility. The only satisfactory definition of the useful is that it contributes definitely and positively to fullness of life. From that point of view it is useful to teach a ploughboy to love poetry and not useful to teach a public schoolboy to hate Greek. This is not an argument against teaching a subject the disappearance of which from our education would be an irreparable disaster. It means merely that the literatures of the ancient world, when taught, should be taught in such a way as to contribute positively to the quality of a modern life. But the term "useful," according to the definition, certainly includes utility in the narrower sense. The daily work of the world must be kept going, and one of the essential tasks of the schools is to fit the young to carry it on under the immensely complicated conditions of present-day civilisation. The only limitation imposed by our argument is that what is conservative in purpose shall be creative in its method and, being so, shall embody some dignified tradition of practical, æsthetic, or intellectual activity. The condition may be satisfied by a technical education based upon many of the great historic occupations of men and women, provided that inspiration is sought from the traditions of the industry or craft at their noblest. To conceive "secondary education for all" as meaning "the grammar school curriculum for all" would be to make a most serious blunder. The only mistake more serious would be to exclude adolescent boys and girls, even of the humblest station, from any essential part of the national inheritance of culture. But this error may be avoided while full account is yet taken of the far-reaching differences in the talents and *ingenium* of individuals and the rich diversity of the valuable currents, intellectual, practical, and æsthetic, in the life of the community, of which any one may be made the basis of a course truly liberal in quality.

The last hundred years have greatly accentuated the gravity of a problem which was discerned by the poet Schiller and diagnosed in the famous "Letters on Æsthetic Education" he published in 1795. In Schiller's view the immense progress of the modern nations has been purchased at the expense of the development of the individual soul, so that, in spite of the greatness of our achievements, we are, man for man, inferior to the various and well-rounded Athenians of the best days. It is the division of labour essential to a large-scale organisation of society which has at once made general progress possible and individual impoverishment inevitable, for it has cut individual men off from experiences that are indispensable to the full well-being of mankind. If this was true in the days of the French Revolution, how much more true it is to-day, and how much more grave the evil. We are told that before the era of industrialism the great mass of our people enjoyed a culture which, though simple, was sincere and at least kept them in touch with the springs of beauty. What truth there is in the picture I do not know, but it is certain that with what is called the industrial revolution the conditions that make it credible largely disappeared. Torn from the traditions of the old rural life and domestic industry and herded into towns where in the fight for mere existence they lost their hold on all that gave grace to the former life, the folk who now constitute the bulk of our population were cut off effectually from "sweetness and light." That was the situation when the task of public education was taken seriously in hand, and that, notwithstanding a great amelioration in details, is for far too many the situation to-day.

There are some who think that the only remedy is to cry halt to the modern movement and return deliberately to medievalism. That is a counsel of despair; instead of indulging idle dreams it will be more profitable, assuming the unalterable conditions of modern life, to consider how the rest may so be modified as to place the true dignity and grace of life within the reach of all who are qualified to achieve them. That can be done only by a system of education which brings the things of enduring and universal worth to the doors of the common people. It is what has been done by many an elementary school teacher, sometimes with scant assistance from public opinion, simply because, face to face with his helpless charges, he was impelled to give them the best he had to give. It will be done with increasing happy results the more clearly it is seen that the proper function of the elementary schools is something much more than to protect the State against the obvious danger of a grossly ignorant populace or to "educate our masters" in the rudiments of citizenship. Unless it be done, unless the natural hunger of the people for knowledge and beauty be wisely stimulated and widely satisfied, no material prosperity can in the end save the social body from irretrievable degradation and disaster.

New Discoveries and Paintings of Palæolithic Date in the Department of the Lot (France).

THE study of palæolithic man is many-sided. As a geologist, treating the tools and objects manufactured by prehistoric man as fossils, the prehistorian has determined an archæological sequence, and, by correlating this with the geological record of the earth's history, has been able to suggest a probable chronology. As an anatomist, the prehistorian has launched into the fascinating study of the evolution of man, and, although hampered by lack of authentic material, has already been able to show that this evolution was by no means a simple straightforward affair. As fresh material comes to hand it will become possible to elucidate further this complex branch of the subject. As an ethnologist, the prehistorian has attempted to trace the migrations of prehistoric races, and to compare their cultures with those of primitive folk still surviving.

But perhaps the most entrancing branch of prehistory is the study of the mural art of these very early peoples. Here we are not dealing merely with "dry bones" or objects made for some immediate and concrete use, nor indeed are we dealing, in the vast majority of cases, with mere "home" decoration. Primitive man, then as now, was concerned with his food supply, and the art was practised as a form of sympathetic magic. The veil lifts for a moment, revealing to us the very thoughts and aspirations—one might almost say the religion—of these early artists. The occurrence of prehistoric ceremonial burials has further helped in this study, indicating, as it probably does, something of the nature of a cult of the dead. Perhaps some of the cave art may be connected with this.

The palæolithic art for magic purposes occurs emblazoning the walls of caves. The darkness and silence of these entrances to the bowels of the earth is eminently suited to the production in primitive man of a state of mind receptive to magic influences. There is actually evidence to suggest that a priestly artist caste guided and controlled these emotions. The painted and engraved caves may indeed be described as prehistoric temples.

For this art to be practised, it is clearly necessary that natural caves should occur in the district. Hitherto three main areas of distribution have been located, one in Dordogne (France), around the village of Les Eyzies on the banks of the river Vezère, a tributary of the Dordogne; another in the Pyrenees, especially in the department of Ariège; the third in Cantabria (North Spain), and extending as far west as Asturias. It would now appear that, thanks to the energy of the Abbé Lemozi of Cabrerets near Cahors (Lot), a new region is in process of discovery. An announcement of this has appeared in *L'Illustration* of October 13, p. 354. The article, profusely illustrated, deals with the finds of the Abbé Lemozi. It does not pretend to be a scientific exposition written by an expert. On the other hand, an exceedingly interesting sketch is given of the archæological work done by the Abbé, which it is to be hoped he will publish himself in due course. Not only have a number of prehistoric "homes" been discovered under overhanging rocks, many of which have yielded rich industries in stone and bone, but a painted cave temple, worthy to be compared with those of the Dordogne, Pyrenees, and Cantabria, has also been explored.

Judging from the illustrations, the date of the art would seem to be in part Aurignacian, in part lower Magdalenian, but it is impossible to be precise on this point from the meagre account given. The animals and figures observed apparently include reindeer, horse, mammoth, bison, "negative" human hands, signs, etc. Obviously much further work is required before what promises to be a new and rich area is properly explored, but the Abbé is to be congratulated on what he has already done, and *L'Illustration* is to be highly commended for having brought forward his work in such an excellent way. A complete survey of the district around Cabrerets, with a scientific account of the diggings and of the cave art, will be eagerly awaited by all prehistorians. Some reproductions of the new prehistoric paintings appeared in the *Illustrated London News* of October 20.

M. C. B.

An African Chalicothere.

By Dr. CHAS. W. ANDREWS, F.R.S.

A SMALL collection of fossils from the neighbourhood of Albert Nyanza has recently been sent for determination to the British Museum by Mr. E. J. Wayland, director of the Geological Survey of Uganda. The beds from which these remains were derived are of late Pliocene or, more probably, Pleistocene age, since they include teeth of Hippopotamus and Phacochœrus which do not seem to be distinguishable from those of recent forms: with these are bones of crocodiles, Chelonia, a large Siluroid fish, and fresh-water shells.

Accompanying these remains there are two or three fragments of much greater interest. The most important is a phalangeal bone of such peculiar form that it is at once seen to belong to a member of the Ancylopoda (Chalicotheroidea). These animals are very aberrant perissodactyl ungulates in which, instead of hoofs, great cleft claws are developed, and the consequent modification of the foot bones is such that even a single phalangeal bone is easily recognisable. These large cleft claws were known so long ago as Cuvier's time, and he regarded them as belonging to a giant Manis ("Pangolin gigantesque"). It was not until 1888 that Filhol was able to prove that they actually belong to an ungulate. The group first appears in the Middle Eocene of North America, and in later times it spread over the northern hemisphere, remains being found in the Upper Miocene beds of Samos and Pikermi, and in India and China in deposits as late as the Pleistocene.

The finding of a Chalicothere in Central Africa is of especial interest because a species occurs in Samos associated with Samotherium, which is very closely similar to the Okapi, the discovery of which a few years ago attracted so much attention. It seems just possible that a Chalicothere may still survive in the same region and may be the basis of the persistent rumours of the existence of a large bear- or hyæna-like animal. For example, in a letter to Mr. M. A. C. Hinton from Capt. C. R. S. Pitman, of Kenya Colony, the writer inquires if anything is known of the "Nandi Bear," stories of which are constantly cropping up. Whatever it may turn out to be, the beast seems to be nocturnal in its habits and to resemble a very large hyæna, an animal in which the proportions of the fore and hind limbs are much as in some Chalicotheres.

It is to be hoped that great efforts will be made to settle what this creature is, since, if the suggestion made above turns out to be correct, it will be a discovery of far greater interest than the Okapi. It does not seem at all improbable that, in such a country, even a large nocturnal animal might escape notice for a long time: even in England few people have ever seen a badger in the wild state.

Obituary.

The Hon. N. C. Rothschild.

By the death on October 12, at the age of forty-six, of the Hon. Nathaniel Charles Rothschild, younger son of the first Lord Rothschild, Nature in a literal sense, entomology, and, it may be added, tropical medicine have each sustained a formidable blow. For Mr. Rothschild, whose career demonstrated in striking fashion that the pursuit of business is by no means incompatible with scientific achievement of the first rank, was at one and the same time an active partner in the firm of Messrs. N. M. Rothschild and Sons; the mainstay of the Society for the Promotion of Nature Reserves, to which he contributed practically all the funds at its disposal; and the leading authority on the Siphonaptera, or fleas, certain species of which are responsible for the dissemination of plague.

In 1895, on leaving Harrow, where, in conjunction with the late J. L. Bonhote, he had already while still a schoolboy produced a volume on the local butterflies and moths, Charles Rothschild went up to Trinity College, Cambridge, where three years later he obtained honours in Part I. of the Natural Sciences Tripos. After entering the City, besides devoting himself to his more immediate interests at New Court, Mr. Rothschild became chairman of the Alliance Assurance Company. The outbreak of the War caused him to become closely connected with, and to undertake most important work for, more than one Government Department; and his father's various duties, which were assumed by Mr. Rothschild on the death of the former in the spring of 1915, added to the strain of his many responsibilities. Overwork, cruelly prolonged, resulted in 1916 in a nervous breakdown, and from this Charles Rothschild never fully recovered; so that his lamented death at a comparatively early age was clearly an after-result of the War.

Mr. Rothschild, who was a Justice of the Peace and had been High Sheriff for Northamptonshire, was also a lieutenant for the City of London, and was president of the Entomological Society of London in 1915 and 1916. In addition, he was a fellow or member of many scientific and learned societies both at home and abroad, and had been a member of the honorary committee of management of the Imperial Bureau of Entomology, from the formation of the latter, as the Entomological Research Committee, in 1909. His presidential address to the Entomological Society on January 19, 1916, consisted in the main of an earnest plea for the preservation of many species among the British fauna and flora, now fast disappearing, or on the verge of, at any rate, local extinction; and appealed for support for the Society for the Promotion of Nature Reserves, and for the work of the National Trust for the Preservation of Places of Natural Beauty or Historical Interest.

Even in these days of specialisation, it is given to few zoological systematists to possess an encyclopædic and practically unique knowledge of an entire group. But Charles Rothschild soon became, as he remained until the end, the leading authority upon Siphonaptera; and to him, more than to any other, existing, accurate knowledge of the fleas of the world is due. Prior to Rothschild's day, the study of Siphonaptera lagged far behind that of most other orders of insects, and in fact, with a few notable exceptions, such as Taschenberg and C. F. Baker, had been almost entirely neglected by entomologists. Rothschild, however, was a prolific writer upon his favourite subject, and, while steadily accumulating his unrivalled collection of fleas, both exotic and endemic, he continued for a quarter of a century to diagnose and describe his material in a series of papers and monographs of the utmost value. The first papers by Mr. Rothschild on Siphonaptera (diagnoses of two new species of British fleas) appeared in 1897, when their author was but twenty years of age. Subsequently his interest was extended to the Siphonaptera of the entire world, and, in the interval between the appearance of his earliest contributions and last year, when the latest memoir written by him (a report upon the Siphonaptera collected by the Norwegian Expedition to Novaya Zemlya in 1921) was published, he was responsible, either singly or in conjunction with Dr. K. Jordan, his gifted collaborator, for a very large number of authoritative contributions to the literature of this group of ectoparasites.

Some ten years ago Mr. Rothschild, who was a generous and frequent benefactor to the Natural History Departments of the British Museum, presented to the Trustees of that institution his entire collection of Siphonaptera and other ectoparasites, with the proviso that the collection should remain in his hands during his lifetime. It is understood that the donor also set apart a sum of money, the interest of which, when the collection is handed over to the nation, is to be applied to its maintenance and improvement. E. E. A.

Mr. William Thomson.

Mr. William Thomson, F.R.S.(Ed.), F.I.C., the eminent Manchester consulting chemist and analyst, who died suddenly in his Laboratory on October 4, was a prominent figure in the chemical circles of Manchester and London during the last fifty years. Born in 1851 in Glasgow, he went to Manchester in 1869, and entered as assistant to Dr. Crace-Calvert at the Royal Institution Laboratory in Princess Street. Four years later, on August 25, 1873, at the age of twenty-two, he became a partner in the firm of Crace-Calvert and Thomson, and on the death of Dr. Crace-Calvert two months afterwards, took sole charge of the practice, and combined with this the office of public analyst for Stockport, which he continued to the time of his death.

Mr. Thomson joined the Manchester Literary and Philosophical Society in 1873, and served on the council for many years, acting as president from 1917 to 1919. The Society is the richer for his contributions on different subjects of scientific interest, some of which during his lifetime developed into renowned discoveries. Only in November of last year he presented to the Society the actual tubes containing sulphides of calcium, barium, etc., with which in 1877 he brought to the notice of Sir William Crookes the phosphorescent properties of these substances. They proved to be the first of three steps which led to the discovery of X-rays by Prof. Röntgen. He is also known for his work on the detection of arsenic in beer during the

outbreak of arsenical poisoning some years ago, and for his indefatigable and original work on the amount of soot in the smoke-laden atmosphere of Manchester. His efforts in association with the Manchester and Salford Sanitary Association to obtain a purer atmosphere should be a memorial to him among the public of that city.

In recognition of his many original contributions to science, Thomson was elected a fellow of the Royal Society of Edinburgh in 1876. He was also one of the original members of the Society of Chemical Industry, was elected to the committee in October 1884, and acted as chairman of the Manchester Section for some years. He was a prominent member of the Institute of Chemistry, of which he was elected a fellow in 1877; he served on the council from 1887 to 1890 and from 1893 to 1896. For some years also he was on the committee of the Society of Dyers and Colourists. He was the author of a book on "The Sizing of Cotton Goods," of which the first edition was published in 1877 and the second in 1879.

SIR WILLIAM RICE EDWARDS, K.C.B., K.C.I.E., C.M.G.

THE death on October 13 of Major-General Sir William Rice Edwards from pneumonia, after a very brief illness, at the comparatively early age of sixty-one, has come as a great shock to his many friends, and especially to the members of his service, who trusted and honoured him as their chief and loved him as an upright and sporting gentleman. He studied at the London Hospital, took the M.B. with honours and later the M.D. of Durham, and entered the Indian Medical Service in 1886, serving in his earlier years at the Eden Hospital, Calcutta, and on Lord Roberts's staff in India and later during the South African War, and was Residency Surgeon in Kashmir for some years before selection for the administrative grade. After a successful period as Surgeon-General, Bengal, where his abilities and accessibility endeared him to all who had the privilege of serving under him, he succeeded Sir Pardey Lukis in 1918 as Director-General at the most critical period in the history of the Indian Medical Service. He fought unflinchingly, without the least regard to his personal prospects, for the Service, first to obtain justice with regard to the increased pay recommended by the Public Services Commission, and afterwards to lessen, so far as possible, the disastrous effects of the Montague reform scheme. He succeeded in the first, with the help of the British Medical Association, but regretfully admitted, when speaking as chairman of the I.M.S. dinner only last June, that he had failed to a large extent in the latter superhuman task. He did much to foster the scientific work of the bacteriological department, while the successful organisation of the Calcutta School of Tropical Medicine was due in no small degree to his invaluable support.

BY the death, on September 4, of Prof. Dr. Paul Friedländer another favourite and successful pupil of Adolf von Baeyer has passed away. He had many friends and was highly esteemed by his colleagues beyond the boundaries of his native country. Paul Friedländer was born in 1857 at Königsberg, Prussia, where, having finished his school education, he began his academic studies under Graebe, and continued them in Strasbourg and Munich under A. v. Baeyer in 1878, whose private assistant he was at the time. From 1884 to 1887 Friedländer was chief chemist of the scientific laboratory of the Oehler Works at Offenbach a.M. Afterwards he entered upon his academic career in 1888 at Karlsruhe, where he was made professor-extraordinary in 1889; from 1895 to 1911 he was professor at the Museum of Industrial Technology in Vienna, whence he passed to Darmstadt as professor of chemistry of dyestuffs. Friedländer's most important work was connected with the group of indigo dyes; he found that the ancient Tyrian purple, the dyestuff of the shellfishes, contains highly brominated indigo derivatives; his discovery of thio-indigo red, a sulphur derivative of indigo, was most important in the development of vat dye manufacture, and enabled Friedländer to find a number of new compounds. His main literary work is well known and in daily use by colour and dyestuff chemists, though, so far as we know, published in German only.

MR. ARTHUR L. DEARLOVE, who died on October 19, was a well-known consulting engineer. He was senior partner in the firm of Messrs. Clark, Forde and Taylor. He superintended the laying of many thousands of miles of submarine cable, and did a large amount of cable work during the War. He did much careful research work on the Clark and Weston standard cells, and contributed largely to the technical journals.

WE regret to announce the following deaths:

Prof. Carl Harries, honorary professor of the Technical High School at Charlottenburg, and formerly professor of chemistry at Kiel, who was known for his work on the action of sodium on isoprene, aged fifty-seven.

Prof. P. W. Latham, formerly Downing professor of medicine in the University of Cambridge, on October 29, aged ninety-one.

Dr. Charles Frederick Millspaugh, curator of the department of botany of the Field Museum, Chicago, and professor of botany at the University of Chicago and the Chicago Medical College, on September 15 aged sixty-nine.

Prof. F. P. Spalding, of the School of Engineering of the University of Missouri since 1900, on September 4, aged sixty-six.

Dr. J. E. Stead, F.R.S., president of the Iron and Steel Institute 1920–21, on October 31, aged seventy-two.

Dr. A. Stutzer, the well-known agricultural chemist of the University of Königsberg, who has carried out many researches both alone and with collaborators on Chile saltpetre, soil organisms, and nitrifying and denitrifying bacteria, on September 3, aged seventy-four.

Prof. James Sully, emeritus professor of philosophy, University College, London, on November 1, aged eighty-one.

Current Topics and Events.

H.M. the King has approved of the following awards this year by the president and council of the Royal Society:—A Royal medal to Sir Napier Shaw, for his researches in meteorological science; a Royal medal to Prof. C. J. Martin, for his researches on animal metabolism. The following awards have also been made by the president and council:—The Copley medal to Prof. H. Lamb, for his researches in mathematical physics; the Davy medal to Prof. H. B. Baker, for his researches on the complete drying of gases and liquids; and the Hughes medal to Prof. R. A. Millikan, for his determination of the electronic charge and of other physical constants.

The following is a list of those recommended by the president and council of the Royal Society for election to the council at the anniversary meeting on November 30:—*President*: Sir Charles Sherrington; *Treasurer*: Sir David Prain; *Secretaries*: Mr. W. B. Hardy and Mr. J. H. Jeans; *Foreign Secretary*: Sir Arthur Schuster; *Other Members of Council*: Sir Frederick Andrewes, Prof. C. G. Barkla, Sir William Bragg, Prof. W. E. Dalby, Prof. A. S. Eddington, Prof. T. R. Elliott, Prof. E. S. Goodrich, Sir Sidney Harmer, Sir Thomas Holland, Sir Frederick Keeble, Prof. T. R. Merton, Prof. H. F. Newall, Prof. D. Noel Paton, Dr. A. Scott, Mr. F. E. Smith, and Prof. J. F. Thorpe.

On Saturday, November 3, His Majesty the King of Sweden, accompanied by Baron Palmstierna, the Swedish Minister, and the Royal Suite, visited the Linnean Society's rooms in Burlington House, and was received by Dr. A. B. Rendle, the president, the officers, council, and staff. An inspection was made of the various objects of interest connected with the great Swedish naturalist, Carl von Linné, such as his herbarium and zoological collections, manuscripts, correspondence, and volumes copiously annotated by their author. Before leaving, the King signed the Roll and Charter Book of the Society, on the emblazoned vellum page specially prepared for signature.

According to a telegram from New York which appeared in the *Times* of October 31, an expedition of the Smithsonian Institution, of which Dr. J. P. Harrington is the head, has discovered, at Santa Barbara, in California, two human skulls for which a very high antiquity is claimed. They are said to belong to an era far earlier than that of Neanderthal man. The evidence upon which this claim is based would appear to be a low forehead and very pronounced eyebrow ridges. The mouth cavity is extremely large and the walls of the skull very thick. They are said to be twice the thickness of ancient Indians' skulls. Until more detailed evidence is available, judgment must be suspended as to the likelihood of this claim to a high antiquity being substantiated; but it may be pointed out that skulls exhibiting Neanderthaloid characteristics, especially in the pronounced eyebrow ridges, have been found on more than one occasion in the United States. Although a great age has been attributed to them, upon further examination they have been pronounced to be merely a relatively modern variety of the Indian type. It is significant that the new Santa Barbara skulls were associated with a material culture, implements, fish-hooks, etc., which is said to show a great advance upon any culture that can be associated with Neanderthal man.

The *Times* of November 1 contains an interesting account by its Peking correspondent of some results of the American Expedition to Mongolia organised by Prof. Osborn and led by Mr. R. C. Andrews, which included Mr. W. Granger as palæontologist, and Mr. F. K. Morris as zoologist. The expedition was despatched in consequence of the reported existence of vertebrate fossils in Mongolia. Mr. Andrews, in a preliminary visit to the area, found indications that a systematic search might yield a rich harvest of Mesozoic vertebrates. The expedition with five motors and seventy camels travelled through Kalgan to part of the Gobi Desert—about 300 miles south-west of Urga. Excavations there resulted in the discovery of seventy skulls and twelve complete skeletons. The local conditions are so favourable for the perfect preservation of fossils that fourteen fossil reptile eggs were found, one of which contains an embryo of an unhatched Dinosaur. Five eggs were found in a nest close beside the skeleton of what was presumably the parent reptile. The shells had been cracked and gradually filled by the fine, wind-blown dust which formed the loess. The skeletons are Mesozoic Dinosaurs and are regarded by Prof. Osborn as the ancestors of the famous fossil horned reptiles of Montana. One of them has been named *Protoceratops andrewsi*. Prof. Osborn considers that the Dinosaurs developed in the northern plains of the Old World and thence crossed into America through northern China. The collections are being taken to the American Museum in New York. It is hoped that funds will be raised to continue the work in Mongolia on a still larger scale. Preliminary technical reports on the discoveries have been already published in America, and announced by members of the expedition to the Geological Society of China.

The foundation ceremony at Sukkur in the Province of Sind, India, on October 24, when Sir George Lloyd, the retiring Governor of Bombay, laid a stone which marks the commencement of operations for the construction of an irrigation barrage, is worthy of more than the casual note which has appeared in the daily press. It marks the inception of, perhaps, the largest and most impressive irrigation scheme constructed in any part of the world. Sind, which is one of the driest tracts in India, depends for its irrigation upon inundation canals from the river Indus, the overflow from which is sporadic and fluctuating. In flood times there is a full supply of water; during the cold season only the most fortunately situated areas obtain any supply at all, while a minimum of 20,000 cubic feet of water per second runs waste to the sea. It is the object of the barrage

to regulate the flow so as to secure an adequate supply throughout the year. The barrage structure will be the largest of its kind in the world, far exceeding the Assuan Dam. It will measure 4725 feet between the faces of the regulators on each side. These regulators are seven in number, and of the canals they feed, three will be wider than the Suez Canal, and the central rice canal will have a discharge equal to that of the Thames. The gross area commanded by the works embraces 7½ million acres, of which 6½ million acres are culturable, and an annual area of 5¼ million acres under irrigation is contemplated. The total cultivated area in Egypt is thus exceeded by half a million acres in this one scheme for a single province in India. The estimated outlay on the project amounts to more than twelve millions sterling.

APPARENTLY the principle of organic evolution is still under public discussion in the United States through Mr. W. J. Bryan's campaign against it. The Journal of the Washington Academy of Sciences (vol. 16, No. 13, October) contains the following amusing comments by Dr. C. W. Stiles from the Proceedings of the Biological Society of America, which is affiliated with the Academy: "According to Mr. Bryan's premises, all germs which cause disease must have been created in the beginning as they exist to-day. If it is to be conceded that these germs were originally created in some form other than as disease germs, the theory of evolution stands admitted. Obviously, since Adam was the last animal created and since the animals were not created until after the plants, it is unthinkable that any of the numerous germs which cause disease were created after Adam. Since disease germs are dependent for their existence upon animals and plants in which they cause disease, it is clear that these germs could not have been created or have existed prior to the creation of their victims. A challenge of this deduction would be an admission that the germs were not created as they are to-day, but that they later evolved into disease germs; but this would be an admission of evolution. Therefore, if Mr. Bryan's challenge is to be accepted, we must conclude that Adam harbored every germ disease which is characteristic of man or dependent on man for its life cycle."

A CRITICAL examination of Berthelot's work on Arabic chemistry has been published by Mr. E. J. Holmyard in *Chemistry and Industry* (Oct. 5 and 12). The criticism is arranged under three headings, dealing respectively with Berthelot's qualifications for his task, with his choice of material, and with his treatment of the material chosen. It is concluded that Berthelot undoubtedly possessed the necessary scientific qualifications, but was hampered by having to rely on translations from the Arabic which were not wholly accurate from a technical point of view. He also devoted his attention to three points only, namely, the Arabic originals of Latin works, to the influence of the Greek alchemists, and to the works of Jābir ibn Hayyān and their relation to the Latin works of Geber. The choice of material in the last case was quite inadequate. Berthelot's treatment of the material chosen was arbitrary and sometimes superficial, the most important Latin work at his disposal ("Liber de Septuaginta") receiving insufficient consideration. Although some recent criticism of Berthelot's undoubtedly great services to the history of chemistry has probably gone further than is justifiable, the conclusions of Mr. Holmyard, if accepted, will make it necessary to exercise great caution in following the French author in his treatment of Arabic chemistry. The great gap in our knowledge of the middle period of Arabic chemistry, to which Mr. Holmyard refers, will have to be filled in before any definite conclusions can be drawn as to the general influence of the workers of Islam on the progress of chemical thought. It may even now be asserted, however, that the judgments of previous historians may require modifications in several directions. Although some distinguished Orientalists abroad, notably Prof. E. Wiedemann and Prof. Ruska, have performed most valuable services in the region of Arabic science, the attention of other students is much to be desired.

DR. H. LEVINSTEIN, who is a member of the scientific committee directing the chemical exhibits for the British Empire Exhibition at Wembley, in the course of some remarks made recently, stated that the pure chemistry exhibit is being organised by a committee representing all the relevant scientific societies, supported and greatly assisted by the advice and co-operation of the Royal Society. The intention is to produce an exhibit which will make plain to the world what British men of science have done and are doing to build up the science of chemistry as it is known in the world to-day. The pure chemistry exhibit at Wembley should for ever destroy the illusion, which had some justification in the past, that British university training and research in chemistry is below the highest standard of other countries. This would not have been true in the same sense thirty years ago. The following conveners have agreed to organise the various sections of the chemical exhibit: Sir Ernest Rutherford (structure of the atom), Prof. J. C. McLennan (spectroscopy), Sir Henry Miers (crystallography and crystal structure), Dr. A. Lapworth (valency theories and theories of chemical combination), Dr. T. Slater Price (photography), Prof. F. G. Donnan (general physical chemistry), Dr. Alexander Scott (atomic weight determination), Mr. A. Chaston Chapman (analysis: hydrogen ion concentration), Prof. E. C. C. Baly (general inorganic), Prof. A. Smithells (flame, fuel, and explosion waves), Dr. Henry and Prof. F. L. Pyman (organic chemistry), Mr. J. L. Baker (biochemistry), Sir John Russell (agricultural chemistry), Principal J. C. Irvine (sugars), Prof. G. G. Henderson (terpenes), Prof. I. M. Heilbron (plant colouring matters), Dr. J. T. Hewitt (coal-tar colouring matters), Prof. J. F. Thorpe (general organic chemistry), Mr. C. F. Cross (cellulose), Dr. E. F. Armstrong (catalysis), Mr. W. F. Reid (explosives), Dr. W. R. Ormandy (plastics), Commander

R. E. Stokes-Rees (apparatus), Prof. J. W. Hinchley, (chemical engineering), Mr. R. B. Pilcher (historical).

The first World Power Conference will be held on June 30–July 12 next at the British Empire Exhibition. It has been promoted by the British Electrical and Allied Manufacturers' Association (the B.E.A.M.A.), in co-operation with many technical and scientific institutions. The subject discussed will be the production and generation of energy in all its forms. It is very satisfactory to notice that practically every civilised country is sending delegates, and many engineers of world-wide eminence will read papers on power generation and distribution, and on electric traction. Considering what different solutions have been standardised in the various countries, a comparison of costs will lead to results of permanent value. One point, however, that the promoters of this international conference seem to have overlooked is that the date of the centenary of the birth of Lord Kelvin is on June 26. Few, therefore, of the eminent delegates will be able to take part in the celebration. As Lord Kelvin is admittedly the greatest physicist of the Victorian age, and possibly the greatest natural philosopher since Sir Isaac Newton, foreign men of science and engineers will doubtless want to take part in our celebrations.

The opening meeting of the new session of the Newcomen Society for the Study of the History of Engineering and Technology was held on Friday, October 26, in the appropriate atmosphere of Prince Henry's Room, Fleet Street, when the president, Loughnan St. L. Pendred, delivered his presidential address on "The Value of the History of Technology." Mr. Pendred said he had in the first instance examined what were the views held as to the use of history in general, and, in spite of all that had been written on the subject, he found it impossible to believe, for example, that the events of the Hundred Years War were of the slightest use to us in the recent struggle with Germany or that the Battle of Jutland owed anything to Admiral Mahan's examination of Nelson's orders at Trafalgar. The importance of history resided in its evolutionary characteristics, and in this aspect technology, reflecting as it does the most important endeavours of mankind from the earliest times, is as worthy of serious investigation as those natural causes by which man himself was developed from a lower creation. Strange as it may appear, development has never received a modicum of the attention that is paid to systems of philosophy, yet these have made far less difference to the world than have advances in technology. This is partly the case because, while the documentation of the ordinary forms of history is abundant, that for the relationships of human progress to technical development is scanty. Mr. Pendred also alluded to the value of the historical method in teaching technology and, by inspiration from its achievements, in the formation of character.

October rains were heavy over the British Islands, especially in the midland, western, and south-eastern districts. In London, according to the Greenwich observations, the total rainfall for the month was 5·07 in., falling on twenty-three days. October was by far the wettest month so far this year; the next wettest month was February, with 2·65 in. The monthly total is the heaviest since July 1918, when the fall was 7·35 in.; it is the wettest October since 1882, when the measurement for the month was 5·42 in., though in 1880 the rainfall for October was 7·65 in., the heaviest for the corresponding month for upwards of 100 years. At Greenwich the rainfall this year for the ten months to the end of October is 20·37 in., which is 1·41 in. more than the normal. At Eastbourne the rainfall, measured in the Old Town, for October was 7·48 in., rain falling on twenty-three days; the measurement for twenty-four hours on the morning of October 24 was 1·51 in. In 1889 the October rainfall at Eastbourne was 8·15 in., and in December 1915 the measurement was 8·37 in. The excess of rain at Eastbourne for the last ten months is nearly 7 inches. At the Rothamsted Experimental Station, according to the *Times* of November 3, the rainfall in October measured 4·97 in., an excess of 1·91 in.; of this 3·45 in. drained through 60 inches of soil, against an average for October of 1·67 in., giving an excess of 1·78 in. The soil is saturated, and it seems probable that the winter rains will increase the supply of underground water, which is still deficient.

A general discussion on "Electrode Reactions and Equilibria" will be held by the Faraday Society meeting at the Institution of Electrical Engineers on Monday, November 26. The first session of the meeting will extend from 3 to 5 p.m., and will deal with "Conditions of Equilibrium at Reversible Electrodes." Sir Robert Robertson, president of the Society, will preside, and the introductory address will be given by Dr. E. K. Rideal. Among the speakers will be Prof. Biilman, of Copenhagen, who will read a paper on "Some Oxidation and Reduction Electrodes and their importance to Organic Chemistry." After an interval for tea the meeting will resume at 5.30 p.m., and will devote itself to the consideration of "Irreversible Electrode Effects, including Passivity and Overvoltage." Prof. F. G. Donnan, vice-president, will preside over this session, and the introductory address will be given by Prof. A. J. Allmand. At the conclusion of the meeting a dinner will be held at the Holborn Restaurant to be followed by an informal conference. Members of the Chemical Society, the Physical Society, and the Institution of Electrical Engineers, have been invited to attend this discussion. Others interested should apply to the Secretary of the Faraday Society, 10 Essex Street, London, W.C.2, from whom a full programme may be obtained.

Col. Rookes Evelyn Bell Crompton, past-president, has been elected an honorary member of the Institution of Electrical Engineers.

At a general meeting of the members of the Royal Institution held on November 5, the thanks of the members were returned to Mr. F. Coston Taylor for his donation of one hundred guineas to the research fund, and to Mr. Robert Mond for his gift of busts

and medallions of Dr. Ludwig Mond, Cannizzaro, Liebig, Berzelius, and others; statuette of Sir James Dewar, and many portraits and photographs. The death of Prof. Jules Violle, an honorary member of the Institution, was announced, and a resolution of condolence with the family was passed.

THE Dr. Mann Juvenile Lectures of the Royal Society of Arts for the new session will be delivered respectively by Prof. W. A. Bone and Mrs. J. W. Henshaw. Prof. Bone's lectures will deal with "Fire and Explosions," and be given on January 2 and 9. Mrs. Henshaw's lecture, entitled "Among the Selkirk Mountains of Canada, with Ice-axe and Camera," will be given on January 16. The lecture hour in each case will be 3 o'clock.

A TECHNICAL assistant is required by the Royal Aircraft Establishment, South Farnborough, Hants, whose duties will be research in problems relating to electric ignition. Candidates should possess an honours degree in physics or electrical engineering, or equivalent qualifications, and have had experience of research work in electrical subjects, preferably in connexion with high frequency work. Applications should be addressed to the Superintendent of the Royal Aircraft Establishment, quoting reference A20.

THE Department of Agriculture in Kenya is requiring an agricultural assistant to help the director and deputy-director of agriculture in supervising agricultural work, particularly native agricultural services. Candidates should possess a degree or diploma in agriculture, a good knowledge of tropical agriculture, and have had experience in agricultural practice. Written applications for the post should be sent to the Assistant Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1, upon forms obtainable from the same address.

MR. B. M. HEADICAR, honorary secretary of the Universities' Library for Central Europe, sends us a list of German chemical literature at his disposal for exchange for similar English literature published since 1914. Alternatively any literature of scientific interest would be accepted and a *quid pro quo* exchange is not stipulated. Inquiries may be addressed to Mr. Headicar at the London School of Economics, Clare Market, London, W.C.2. The list includes volumes of the *Berliner Berichte*, *Zeitschrift fur angewandte Chemie*, *Chemiker Zeitung*, "Technisch-Chemisches Jahrbuch," Abegg's "Handbuch der anorganischen Chemie," and *Zeitschrift fur Chemie und Industrie der Kolloide*.

THE October number of the Journal of the Royal Photographic Society is devoted to the Society's Exhibition. It is copiously illustrated and contains several articles which refer chiefly to pictorial matters. But Dr. B. T. J. Glover, of Liverpool, writes as "a technician," and points out, with examples, how often the gradation of the prints is falsified by under exposure, over development, and manipulation, as in the making of gum prints and bromoils. Indeed with regard to bromoils he asks, "Can any one show me a bromoil print in which they [tone values] are right?" As he also gives examples that show "an exquisite quality" resulting from sound photographic technique, a study of his comments cannot fail to be of interest to those who favour pure photography as well as to those who think that photography is not good enough and seek to improve it by what they call "control."

Our Astronomical Column.

A BRIGHT METEOR.—Mr. W. F. Denning writes from Bristol that on November 3, at $6^h\ 23^m$ G.M.T., he observed a large meteor, equal to Venus in brightness, shooting downwards in the southern sky from $295\frac{1}{2}^\circ + 6^\circ$ to $308^\circ - 21^\circ$. The nucleus gave a flash at the end of its flight and left a white streak. The direction of the course of the object was from a radiant point near β Ursæ Majoris, which supplies many meteors at this time of the year and appears to be a well-defined centre of recurrent radiation at various periods of the year. The shower or showers has or have been frequently observed in the last quarter of the year and deserves more thorough investigation.

SPECTROSCOPIC AND TRIGONOMETRICAL PARALLAXES.—A. Pannekoek (*Observatory*, October 1923) gives reasons for believing that the variation of intensity of certain spectral lines is not directly a measure of the star's absolute luminosity, but of the intensity of gravity at its surface, which affects the ionisation of its atmosphere. For the same spectral class the quantity derivable from the spectrum is the ratio of luminosity to mass. The mean spectroscopic parallaxes of groups of stars will not be affected, but those of individual stars will be, if their mass differs from the mean mass of the class. For example, the trigonometrical parallax of ϵ Indi is $0{\cdot}28''$, while $0{\cdot}45''$ has been given as the spectroscopic value. If there is no error in either value, the star's mass is 2·6 times the mean mass of spectral type K5. This would thus appear to be a method of determining the masses of the nearer stars if non-binaries, while the binaries would serve to test the truth of the principle.

W. J. Luyten contributes a paper to Proc. Nat. Acad. Sci. (September 1923) in which he examines the systematic errors of trigonometrical parallaxes. Van Rhijn recently gave reasons for thinking them to be too large from a study of the proper motions and radial velocities. Luyten uses the same material as Van Rhijn, but discusses it differently. He deduces two graphs: one by grouping the stars by measured parallaxes and forming a graph connecting mean apparent magnitude with reduced parallax; the other by grouping according to apparent magnitude, and again forming a graph. He considers that the truth lies between his two graphs, and deduces that the Allegheny parallaxes are not too large, as Van Rhijn stated, but if anything too small. He further compares the absolute magnitudes deduced from the measured parallaxes with those deduced from proper motions. He thus obtains for the K0 giants the mean absolute magnitude 0·8 (two independent discussions give 0·6 and 1·0), while the trigonometrical parallaxes give 0·7, again suggesting that the latter are if anything too small.

It is useful to apply these tests, for the spectroscopic parallaxes would be affected by systematic errors in the trigonometrical ones that were used for calibration of the spectral curves.

Research Items.

Indian Villages in the Eastern United States.—Various writers during the eighteenth century mentioned the Indian tribes in the Upper Missouri Valley, but their accounts are vague, and little was known of these tribes until the transfer of Louisiana to the United States. The condition and structure of their abandoned villages have been examined by Mr. D. I. Bushnell in Bulletin No. 77 of the American Bureau of Ethnology. Natural environment influenced the various types of structure. Thus in the densely timbered country to the north, about the head-waters of the Mississippi and far beyond, the mat- and bark-covered wigwams were developed and employed practically to the exclusion of all other forms of dwelling. But in the plains, and in the regions bordering on the great buffalo ranges, the skin-covered tipis predominated, though other forms were sometimes constructed by the same people. The earth lodges erected by the tribes in the Missouri Valley were the most interesting structures east of the Rocky Mountains, and these at once suggest the rotundas, or great council-houses, once built by the Cherokees and Creeks east of the Mississippi. The discussion of these various types of habitation is most instructive, and, as is the case with other publications of the Bureau, the monograph is fully illustrated by admirable photographs.

Purposive or Mechanical Psychology.—In the *Psychological Review* (Vol. 30, No. 4) Prof. Wm. McDougall gives a very clear and interesting account of the rival theories of purposive and mechanical psychology. Some years ago, in his well-known book, "Body and Mind," he reviewed the position as it stood then from the historical and modern point of view; in this paper he reaffirms his belief in purposive psychology and considers that form of mechanistic psychology which is popular now, namely, that of behavourism. He admits that there is no logical reason why behaviourists should necessarily be mechanists, but shows that actually very many of them are. For certain very limited purposes mechanical psychology may have value as providing a convenient terminology; but as soon as a study of personalities is required, then the student is immediately concerned with energy, persistence, ambition, etc., qualities which the mechanistic psychology cannot explain. If a psychology is required which shall be able to explain the life of man in society or to aid those in mental distress, or to direct education, or to further the problems of ethics, politics, or economics, then that psychology must take into account purposes and motives; mechanical psychology as such can know nothing and teach nothing about human motives.

Nitrogen-fixing Bacteria in Leaf Nodules.—L. A. Boodle, in an interesting note in the *Kew Bulletin* (No. 9, for 1923, p. 346), directs attention to the little-known phenomenon of nodules containing nitrogen-fixing bacteria occurring as a rule upon the leaves of some of the tropical Rubiaceæ. The bacteria occur in the seed, between the embryo and endosperm, so that the seedling is infected on germination. The bacteria then establish themselves in the leaf-buds, in a gummy secretion within the stipular sheath, and from thence enter the young leaves through stomata. The nitrogen-fixing capacity of these bacteria has been experimentally established by von Faber; Rao in India recently confirming this fact. It is interesting to learn that native practice in India and Ceylon values highly the leaves of species of Pavetta and Chomelia, which bear nodules harbouring these bacteria, for use as green manure.

New Plants.—Part iv. of the new volume (148) of Curtis's *Botanical Magazine* contains several plants of especial systematic interest. *Clethra Delavayi*, Franch, belongs to a genus regarded as having Ericoid affinities, although with free petals. Reasons have also been given for placing Clethra with the Theaceæ and Dilleniaceæ among the more primitive Parietales, but Dr. Stapf argues that our respect for the taxonomic value of gamopetaly must make us resist a recent suggestion to bring the Ericaceæ also over to the side of the Theaceæ. *Carmichaelia australis*, R. Br., is a plant belonging to a remarkable genus, almost confined to New Zealand, not before illustrated in this work. Cheeseman terms the genus the most difficult in the New Zealand flora for the systematist; "everything but the pods seems to be in a state of flux." *Rhododendron sinogrande*, Balf. f. et W. W. Smith, was regarded by Sir I. Bailey Balfour as the Chinese representative of the Himalayan *R. grande*, Wall. It is described as having "the finest leaves of any evergreen yet seen in this country." Admiral H. Lynes is quoted for an admirable description of the habitat on the Lake Chad-Nile divide where the brilliantly coloured *Hæmanthus Lynesii*, Stapf, was first discovered. The new species is illustrated from one of the last plants sent in to Kew by the late Mr. Elwes from his garden at Colesborne Park. *Wattakaka sinensis*, Stapf, is a climbing Asclepiad, which has figured under many generic names, but Dr. Stapf agrees with recent systematic reports that the Chinese species must go with its Malayan fellow, *W. volubilis*, into a separate genus, the name for which is derived from the Malayan species. *Echium cœleste*, Stapf, is another endemic species confined to a very restricted area within the Canary Islands. There are already three other endemic species of Echium known from the island of Palma, and one of these, *E. gentianoides*, like the present species, is known only from the mountains above Garafia. *E. cœleste* is perhaps the most beautiful of this striking group of endemics, and may therefore be of interest to horticulturists, as several striking hybrids have already been produced from species of Echium.

Australian Dung Beetles.—In the Records of the South Australian Museum, vol. ii. No. 3, June 1923, are several noteworthy papers on Australian insects. Mr. Arthur M. Lea treats of the dung beetles of the sub-family Coprides, but in comparison with other parts of the world Australia is poor in indigenous species of these insects. This, however, is scarcely surprising considering the dearth of large indigenous mammals. Dung beetles of several kinds have multiplied with the distribution of domestic animals, and many European species have been introduced. Several of the genera are of exceptional interest, especially Macropocopris, species of which live in fur about the anal region of marsupials, and have developed very powerful claws: one species, *M. symbioticus*, has been found in the cloaca of a wallaby.

Praying Insects of Australia.—The Mantidæ or praying insects of Australia are enumerated by Mr. Norman B. Tindale in the Records of the South Australian Museum, vol. ii. No. 3, June 1923. They are evidently abundantly represented. The known Australian species now number 76, including 4 genera and 16 species added by Mr. Tindale. One of the

most interesting forms is *Bolbe maia* sp. nov., which is the smallest known mantis and attains a length of only 8 mm. Mr. Tindale mentions that it came freely to light in a camp, and was so active that it was very difficult to capture; it often seized flies and other insects which had been likewise attracted. Another new mantid, *Parhierodula majuscula*, is probably the largest Australian member of the family, and the female measures 95 mm. long, while the outspread tegmina have an expanse of 113 mm. A third species, *Orthodera ministralis* Fab., seems to occur in all parts of the continent as well as in Tasmania. It exhibits a wide range of variation, which has resulted in an extensive synonymy; notwithstanding its wide distribution, it does not appear to have developed any clearly defined local races, unless the Tasmanian form is to be regarded as coming under that category.

THE EARLY PROBOSCIDEANS.—Much has been written on the genus Moeritherium, which is known from its remains in the Qasr-el-Sagha beds of the Fayûm in Egypt, and was first described by C. W. Andrews of the British Museum. H. Matsumoto (Bull. Amer. Museum Nat. Hist., vol. 48, p. 97, 1923) now reviews the species, with the aid of specimens in the American Museum of Natural History, and concludes that M. Schlasser was not justified in regarding the smaller forms styled *M. gracile* and *M. trigodon* as sexual varieties respectively of *M. lyonsi* and his species *M. andrewsi*. Schlasser retained only the last two names; Matsumoto points out that, even in that case, the name *trigodon* has priority over Schlasser's *andrewsi*. He concludes, however, that all four species are distinct, and he thus keeps the happily named *M. andrewsi* on the list. He regards some early Moeritherium as ancestral to Palæomastodon, with which three of the known species are associated in the Oligocene (or "Upper Eocene") beds. *M. gracile* is known only from the lower series, the Qasr-el-Sagha beds, here styled Middle Eocene. The author supports the views of Andrews, and emphasises the proboscidean characters as against those that have been held by others to be sirenian. He remarks that, while Moeritherium no doubt haunted watery places, its anatomy does not indicate that it was more aquatic than Hippopotamus.

GEOLOGY OF THE WEALD.—The Geological Survey of Great Britain has issued a memoir on "The Concealed Mesozoic Rocks in Kent," by G. W. Lamplugh, F. L. Kitchin, and J. Pringle (E. Stanford, Ltd., 1923; price 7*s*. 6*d*.). A great deal of interesting information is here brought together as to the floor on which the best-studied Cretaceous rocks in Britain rest, and special attention is directed to the comparison now possible of the Kimmeridge Clay of Kent with that of Dorsetshire. In the Proceedings and Transactions of the Croydon Natural History and Scientific Society, vol. 9, pt. 3 (Croydon: Roffey and Clark; price 5*s*., 1923), Mr. C. C. Fagg, president for 1922, treats of the recession of the chalk escarpment in the district south of Croydon, and shows how the dry gaps have been influenced by the lowering of the surface of the Gault. He points out that the River Mole just below Dorking tends to disappear in summer, and how, in no long geological time, it will cease to run through the gap, and will be captured by tributaries of the Wey. Numerous sections illustrate this paper. It is followed by one by Mr. G. T. McKay on meanders, dealing specially with the Mole. The influence of the veteran geologist, Mr. Wm. Whitaker, at Croydon has clearly been fruitful in guiding geological research.

CHEMICAL PORCELAIN.—An article by Dr. G. N. White on "The Manufacture of English Chemical Porcelain" appears in the *Chemical Age* for Sept. 29. The basis of all pottery is china clay, which is a complex, but relatively unstable, substance, for it decomposes at about 600° C., the products of decomposition being alumina and silica. The latter substances unite only at very high temperatures, about 1650° C.; the use of lower temperatures yields a porous product which is useless for chemical ware. Fluxes are added (*e.g.* silica and felspar mixture), so that a vitrified product results, though for chemical ware the amount added must be a minimum. The article is illustrated with photomicrographs, and types of fracture—mechanical and heat—are discussed.

DEFINITIONS OF PHOTOMETRIC QUANTITIES.—The National Illumination Committee of Great Britain has now supplemented the useful work it has already done in connexion with definitions of the chief photometric quantities by a list of symbols denoting luminous flux (F), candle power (J), illumination (E), and brightness (B). Greek letters are also proposed to indicate reflection, absorption, and transmission ratios. The aim has been twofold: (*a*) to unify existing practice, and (*b*) to avoid possible confusion with international electrical symbols. Explanations of the reasons leading to the adoption of these symbols are given in tabular form. Those for luminous flux, illumination, and brightness are already widely adopted. The only notable departure is in the adoption of "J" for candle power—a symbol general in Germany, but not elsewhere. The reason for rejecting "I," which is at present very generally used, is that this symbol is unfortunately already assigned to current in international electrical nomenclature.

CORROSION OF CONDENSER TUBES.—Some of the more important recent results of the investigations conducted for the Corrosion Committee of the Institute of Metals are contained in a paper presented to the North-east Coast Institution of Engineers and Shipbuilders on October 19 by Dr. Bengough, Mr. R. May, and Miss Pirret. Very rapid corrosion of condenser tubes is essentially a recent trouble, and takes the form of smoothly water-worn depressions, extending over several feet of the tube, and mostly in certain positions. Electrolytic protection fails to prevent it. Should a tube survive the first few weeks under the given conditions, attack of this kind is not likely to occur later. The effects are not due to uneven composition of the tubes or to surface imperfections, and laboratory experiments show that the cause is the presence of entangled air in the water, which in modern practice travels with a high velocity. The critical period in the life of a tube is its early life, before a coating of scale has had an opportunity of forming; once this scale has firmly established itself the resistance to corrosion is very greatly increased. Different waters also differ in regard to their power of foaming, those which readily foam being the most corrosive in presence of air. The attack is usually limited to certain parts of the condenser, and when defects are discovered the renewal of tubes should be limited to those parts, as the wholesale re-tubing of the condenser may mean the removal of a large number of perfectly good tubes which have already received their protective coating of scale. High water speeds and high vacua are the modern conditions that have brought about this trouble. It is suggested that the artificial production of a scale on the tubes before putting into use may be found to be practicable.

Scientific Activities in Birmingham.

THE closing days of October have witnessed two highly interesting and important functions in the educational life of Birmingham. The former of these events was the visit of Sir Robert Hadfield on October 30 to the Metallurgical Society of the University of Birmingham to receive the Thomas Turner Gold Medal and to deliver an address on "The History and Progress of Metallurgical Science and its Influence upon Modern Engineering." In presenting the medal the Principal of the University, Mr. C. Grant Robertson, stated that about three years ago a Birmingham manufacturer, desirous of commemorating the valuable work done by Prof. Turner in metallurgy, generously presented a sum of money to the University to found a Thomas Turner gold medal. The donor stated that it was his express wish that the medal should only be awarded to such persons as had rendered eminent service to metallurgy. In Sir Robert Hadfield they had a man who was not only the head of a large firm of world-wide reputation, but one who was also a fellow of the Royal Society, eminently distinguished by his own metallurgical researches. The authorities were perfectly unanimous in deciding that the first award of the medal should be made to him. Mr. Grant Robertson then handed the medal to Sir Robert, who, after expressing his deep appreciation of the honour conferred upon him, delivered his address. More than three tons of exhibits were on view, and the address was illustrated with lantern slides and a series of unique cinematograph pictures. One slide was particularly impressive. It showed Sir Robert's own motor car together with a $4\frac{1}{2}$ inch projectile. It was pointed out that the car, when travelling at the rate of 60 miles per hour, possessed exactly the same energy as the small projectile on leaving the gun with a velocity of 1100 feet per second. The cinematograph pictures were likewise highly instructive. They included, by special permission of the Directors of Artillery and Naval Ordnance respectively, pictures of the loading and firing of a 15-inch gun. This type of gun, which was used largely during the War, weighs 97 tons, is 57 feet in length, and carries a projectile weighing 1910 lb. At full elevation and with a muzzle velocity of 2500 foot seconds, the range is 20 miles.

Sir Robert's address has been printed *in extenso*, and is issued as a beautifully illustrated monograph which repays careful study. An interesting account is given of modern artillery practice, reference being made to the 18-inch naval gun, the largest yet constructed, which weighs 150 tons, but is now prohibited as the result of the Washington Conference. Armour-piercing projectiles, $1\frac{1}{2}$ tons in weight, were made by Messrs. Hadfield for this gun and could be hurled for a distance of 30 miles. Even at this extreme range they could pierce nearly one foot of ordinary steel armour. Attention is directed to the practical difficulty of hardening these projectiles, for a mass of something like 10,000 cubic inches of steel at 900° C. has to be quenched suddenly in a cold bath. This induces internal strains which may continue for weeks or months, leading to rupture during storage, unless suitable treatment is applied.

A considerable portion of the address is devoted to Birmingham itself, and contains a résumé of the lives of its great men, past and present. It is pointed out that our present Prime Minister, the Rt. Hon. Stanley Baldwin, was once a student in the Metallurgical Department of the old Mason College in Edmund Street, under Prof. Turner. So also was the present Chancellor of the Exchequer, the Rt. Hon. Neville Chamberlain, who was that evening unanimously elected an honorary member of the University Metallurgical Society. Dr. F. W. Aston, a Nobel Prizeman, is another old student of the College.

Birmingham is the second city in England, and the fourth city in the Empire, as regards population. In 1700 it contained 15,000 people, a number that had swelled in 1921 to 920,000. With these figures before us it is natural to inquire into the cause of the steady growth of the city. But upon doing so we are at once confronted with a difficulty. Most of our large industrial cities have received help from their geographical position. What does not London owe, for example, to the Thames; Liverpool to the sea; Manchester to her climate; Sheffield to her mineral wealth? But Birmingham has none of these advantages. Situated in the centre of England, one hundred miles from the sea, helped by no large river, supported by no great mineral wealth, it has nevertheless more than managed to hold its own. This is the more striking when we recollect that Dudley, with all its ancient prestige and mineral wealth, is still a small neighbour; whilst Aston, which once was of far greater importance than Birmingham, has now been swallowed up in the extension of this latter city.

Why is this? There have, no doubt, been many contributory causes. Small things ofttimes determine which rivulet, among many, shall ultimately grow into a mighty river. So with cities. In the twelfth century Henry II. granted to Peter de Bermingham the right to hold a weekly market. This much coveted privilege, though long since obsolete, exerted no small influence on the future of the town, by converting it into an important Midland trading centre. In later years Birmingham became popular for its broad-minded policy of religious toleration, which led many worthy persons to take up residence in the town, thereby strengthening its intellectual life and quickening its industrial vitality.

It not infrequently happens that those whom Nature has most richly endowed fail to achieve greatness because their path through life has been too easy. It may well prove that the very lack of natural advantages, so far from being a hindrance, has actually been one of Birmingham's greatest assets, in that it has taught the sons of Birmingham to rely upon themselves. A strong mental calibre has thus been developed together with a spirit of sturdy independence—attributes that have enabled Birmingham to raise itself to a position of eminence within the Empire. A city that can boast an intimate association with Watt, Boulton, Murdoch, Priestley, Bright, Chamberlain, and scores of others known to fame, need not fear the future.

This brings us to the second event of which we write, namely, the opening by Sir Robert Hadfield on October 31 of a new research laboratory and lecture room in the Chemistry Department of the Birmingham Municipal Technical School. The Principal, Dr. W. E. Sumpner, stated that two years ago these rooms were merely attics filled with lumber. They have now been cleared and made habitable by the Education Committee, the equipment being provided out of funds amounting to more than 400*l.* voluntarily subscribed by local firms. This recognition by manufacturers and others of the value of technical education and research is a most encouraging sign of the times. The Rt. Hon. the Lord Mayor, Alderman Sir David Davis, presided, and in his introductory remarks pointed out that the rooms could not have been opened under more auspicious conditions. The Hadfield Works in Sheffield, the home of manganese steel, are a striking example of the efficiency attainable by the co-operation of science and industry, and

no one could speak with more authority on this subject than Sir Robert Hadfield himself.

The new laboratory has been equipped more particularly for research on corrosion and its prevention. For this purpose it is provided with large corrosion tanks of varying design and with other equipment not usually found in a chemical laboratory. At one end is a dark room containing a magnificent micrographic apparatus purchased with the aid of a grant awarded by the Government Grant Committee of the Royal Society to the head of the Chemistry Department in order to enable him and his research students to study the micrography of corrosion.

As Sir Robert wisely pointed out, the object of a school laboratory is different from that of a works laboratory. The latter is designed to turn out material results; the former is primarily intended for training the men, so that when they pass into industry they will know how to tackle their problems along the most approved lines.

As a further inducement to research three prizes for theses have been offered, namely, one each by Sir Robert Hadfield, the Dunlop Rubber Company, and the Mond Nickel Company respectively. It is hoped that manufacturers and students alike will avail themselves to the full of the new facilities. It is only by the closest co-operation between science and industry that we can hope to capture that portion of the world's trade which is so essential to our national existence.

J. N. F.

Aeroplane Performances.

COMPARISON of the "Wren" light plane with recent U.S.A. Navy racing and fighting aeroplanes shows the price of speed in a definite way. The following table gives some of the more significant figures:

Name.	Power.	Speed Range m./s.	Total Mass.	Lifting Surface.
Wren	$4\frac{1}{2}$ kw.	25/12·5 = 2	175 kg.	11 m²
U.S.A. sea-racer	350 kw.	90/34 = 2·6	1000 kg.	13·5 m²
U.S.A. land-racer	350 kw.	112/33 = 3·4	900 kg.	14·5 m²
U.S.A. land-fighter	300 kw.	76/27 = 2·8	1250 kg.	24·5 m²

The racers have less surface than many of the light planes at Lympne, and the bodies are of the same order of length and cross-section, and show the same scrupulous cleanness of line. To pass from the Wren to the racer, about eighty times the power has been concentrated within the limits of an external surface scarcely distinguishable by the layman from similar types of light plane. The speed obtained is about four and a half times greater. Thus the power required is approximately as the cube of the speed.

This rule is even more accurate in comparing the seaplane with the landplane at the fine incidences occurring at the upper limit of their wide speed ranges. It may be inferred, therefore, that the floats cost half the total power available $(90/112)^3$, in spite of some sacrifice of the lower limit of speed (landing speed), by reduction of surface. The essential inferiority of the seaplane is evident.

In the land-fighter, the inclusion of machine-gun equipment and the reduction of the all-important landing speed to 27 m./s. is obtained by roughly doubling the surface, and sacrificing one-third of the racer's speed, equivalent to about two-thirds of the power.

Great range of speed is always an index of very large margin of power, and therefore of high rate of climb, at sea-level, falling off with height and density, and finally of a high "ceiling" or limit of height attainable.

Assuming liberally in the case of the racer that 100 kw. is required for level flying at 40 m./s. near sea-level, this leaves 250 kw. for climbing. Taking the airscrew efficiency as 0·7 and g as 9·81 m./s², this gives an initial climb of $0{\cdot}7 \times 250 \times 1000$ watts/$900 \times 9{\cdot}81$ m.kg.s.$^{-2}$ = 20 m./s. = 1·2 km./min. To calculate the ceiling height with any accuracy much more precise data are required.

The official height record, of 10·75 km. at this date, rests with France, but the same pilot, M. Sadi Lecointe, has since claimed over 11 km. A U.S.A. claim, not officially accepted in the absence of sufficient control, gives an altitude of 12·5 km., which would mark the invasion by man of the heights of the stratosphere.

The Floor of the North Sea.[1]

THE report on the marine deposits of the south part of the North Sea, referred to below, may be characterised as being long overdue, since it is founded on about 600 samples taken by the Marine Biological Association's steamers in 1904–8, when that Society was undertaking the English share of the International investigations. How extraordinarily efficiently that share of the work was done is illustrated by the reports published on the collections and material and in the peculiar discrimination shown in the selection of these samples. It is common knowledge that much of the substance of this report was known to the Admiralty during the War, proving of value in respect to navigation in foggy and other difficult weather. The area treated, the North Sea roughly from the latitude of the Scottish border to the Straits of Dover, is an exceedingly difficult one on account of the complexity of its past geological changes and the variety of its currents, whether produced by wind or other means, acting in a comparatively shallow sea, much broken by banks (especially in its western parts) and intersected by pits and troughs, of which the Dogger Bank, depth 7 fm., and the Silver Pit, 56 fm., may be mentioned.

The samples were taken out of the material collected by a conical dredge with bag dragged along the bottom and thus selected at each haul out of a considerable quantity of deposit. The colour of the sample was carefully noted, and a series of illustrations of representative samples, showing colour and texture, is published; they are a little hard, as is inevitable with all colour-process work as compared with lithography. The estimations of the amounts of the various grades (determined by least diameters of contents) of gravels, of sands, and of silt were done quantitatively, mainly by means of a special levigating apparatus designed by the author of the report under notice. The different grades after drying and weighing were then examined and their mineral and other contents noted. The absence of the organisms of decay from the samples, which were usually of about 2 kg. weight, was interesting, worms being found still alive after 17 months in the bottles. The percentage present of each sized grade in a sample, having been carefully taken, is multiplied by

[1] Ministry of Agriculture and Fisheries, Fishery Investigations. "The Marine Deposits of the Southern North Sea." By J. O. Borley. (H.M.S.O., 15s. 1923.)

the diameter factor of the grade (least diameter in mm.) and divided by 100, so as to determine the "representative number" of the sample.

The advantage in this technique lies in the fact that the numbers increase roughly in accordance with the increased coarseness of texture of the bottom. The whole method shows a great advance in that it eliminates so far as possible human judgment. It only remained to chart the grounds in accordance with these "representative numbers," this being the basal chart, and then in respect to the percentages present of the grades it was desired to consider especially closely. This has been done in a series of twelve singularly informative charts, which are substituted for the interminable text-descriptions of many authors, a most welcome innovation here with little real loss of matter. The basal chart shows a considerable series of very irregular areas, especially numerous and irregular towards the English coast, and the rest represent the kind of analysis of the bottom material such as would be necessary for the understanding of the conditions, currents and other, that produced these areas. The text shows the actual organic and mineral constituents present in each type of ground.

Thus, while the report is eminently useful to the practical fisherman in his navigation in foggy weather and in telling him about the ground on which he is shooting his nets—each kind of ground is correlated with the abundance or rarity of different species of fish—it constitutes the publication of a research of basal importance in respect to the general erosion of the eastern coasts of England. The bottom, while influenced by land material off each estuary, shows the more gradual passage from the stones or coarse gravels of the English coast to the fine silt of the centre and to the continental sands. The causes of this distribution, so far as present knowledge goes, are attractively discussed—attrition, the grade of material kept in motion by different strengths of currents, the correlation of the areas with the currents as known by independent observations of both surface and bottom movements, and so on.

To conclude, this publication is a practical fisheries report and at the same time a research of very great scientific importance, embodying novel methods of treatment of knowledge and suggesting many further lines of research; the Ministry of Agriculture and Fisheries is to be heartily congratulated on its appearance.

J. S. G.

The Physicist in the Textile Industries.[1]

THE development of the textile industries has been one of the greatest factors in civilisation, but it has been said that the great weakness of the cotton industry—and this applies equally to the other textile industries—is that it is not using to the full the immense powers bestowed on this generation by scientific discovery. In the mill, perfection of manipulation seems, at first glance, to have been attained. It may be said that, if such skill can be developed in the past without the aid of the physicist, then there is no need for him, and this, no doubt, is the attitude of some people whose conservatism still holds them members of the "rule of thumb" school. It is impossible not to admire what has been achieved by such methods, but at the same time one cannot help but wonder what advantages might have been gained had the great skill of the operative been united with the insight of a trained scientific mind. For example, if an attempt is made to probe the inner functions of any of the complicated, or simpler, machines, one soon finds how little is really known about the treatment to which the material is being subjected. On inquiry, varieties of explanation are offered, each, no doubt, a carefully weighed opinion, but still, only an opinion. The reason is that many of the investigations that have hitherto been made took place under vaguely defined, and, therefore, unscientific conditions, with the result that other experimenters have held contrary views, and valuable time has been wasted.

Might not the application of scientific methods settle such controversial matters, and possibly in the end lead to improved machines? There is no question of decrying the ability of the skilled operative; his skill based upon years of mill experience can never be attained by a man whose younger years have been spent in training for scientific work. Undoubtedly the duties of scientific workers are complementary to those of the operative. Here lies the opportunity of the physicist—to bring scientific method into the testing rooms, and even into the mill, in order to ensure that tests made upon the various products of the different machines shall be comparable with those obtained at other times, either on the same or similar machines.

[1] Synopsis of a lecture delivered before the Institute of Physics on October 22 by Dr. A. E. Oxley.

The textile industries offer an almost entirely unexplored and unlimited field for the research physicist, and it is not a question of searching for a problem worthy of investigation, but one of selecting, from the great number of attractive problems presented, a few which shall form the most trustworthy basis on which to build a secure foundation for the development of a progressive research programme. It should be remembered that physical research in the textile world is by no means in such an advanced state as it is in the metallurgical world. Although in the textile industries many of the research problems are of a physical nature, and all have a physical aspect, the number of physicists engaged is only about twenty. A brigade of trained physicists would be more in proportion to the problems urgently awaiting solution. It is safe to say that there is no other industry so much in need of co-operation with the physicist as is the great textile group.

There is one outstanding factor which must be brought to the notice of the physicist contemplating textile research, and this applies to textile materials in general. The material he has to investigate is generally of a most disturbing character on account of its variability. The result is that a very careful selection or sampling of the test specimens must be made, and in many cases very laborious series of tests are needed before a result representative of the bulk, which is the only material recognised by the manufacturer, can be obtained. This fact differentiates rather sharply the physicist of textile research from the physicist in other industries.

Slides were shown by the lecturer to illustrate the types of research on which the textile physicist is engaged. These included investigations on (1) rigidity of the single fibre, a property of fundamental importance in spinning; (2) sorting of samples (*a*) to examine the various fibre lengths in pure cottons or mixings, and (*b*) to detect what damage, if any, is caused to the fibres by the different machines; (3) regularity of threads, a property of great importance in the production of threads for weaving fabrics of fine structure; (4) oscillation stresses on threads such as are met with in weaving; and (5) the measurement of the lustre in finished threads and fabrics and the relation of lustre to doubling twist.

University and Educational Intelligence.

BELFAST.—A letter has been received by the Senate of the Queen's University intimating that the late Hugh Wisnom, of Larne, directed his trustees to invest a sum of 1000*l*. for the foundation of an annual scholarship in the University to be called the "Hugh Wisnom Scholarship," to be awarded in such manner as the governing body shall decide for the encouragement of scientific research.

BIRMINGHAM.—The first award of the Thomas Turner gold medal was made on October 30 at a meeting of the Birmingham University Metallurgical Society, when the Principal (Mr. C. Grant Robertson) presented the medal to Sir Robert Hadfield, Bart., in recognition of his distinguished contributions to the metallurgy of steel. The medal is the outcome of a gift of 525*l*. by a Birmingham manufacturer who desired to perpetuate the memory of the work done by Prof. T. Turner in the metallurgy of iron. The money was invested and is held by trustees for the provision of a gold medal, to be called the Thomas Turner gold medal, which is to be awarded from time to time to distinguished metallurgists. A portion of the fund is applied to the award of a bronze medal and a prize of books to a student to be selected annually from one of the metallurgical schools of the district. The obverse of this medal bears the profile of Prof. Turner and on the reverse is the well-known diagram published by him in 1885 showing the relation between silicon content and tensile strength of iron.

BRISTOL.—For the new degree of Bachelor of Agriculture, a curriculum extending over five years has been prescribed—two in the University, two in the recently reopened Royal College of Agriculture, Cirencester, and one in a selected farm.

CAMBRIDGE.—Mr. H. H. Thomas, Downing College, has been appointed University lecturer in botany.

A grant of 100*l*. has been made from the Balfour Fund to Mr. Cyril Crossland, Clare College, in aid of his researches into the biology of the coral reefs and banks of the South Pacific.

The Regius Professor of Physic announces a short series of lectures on the history of medicine. The lectures this term will be on November 13 and 16 at 5 P.M., on "The Hippocratean Period" and "The Alexandrian Period" respectively.

LONDON.—A course of two free public lectures on "Problems of Variation" will be given by Dr. J. W. Heslop Harrison in the department of zoology, Imperial College of Science and Technology, at 5.15 on Thursday and Friday, November 22 and 23.

THE following scholarships for 1923–24 have been awarded by the Institution of Electrical Engineers: Salomons scholarship (value 50*l*.), to Mr. James Linton (Heriot-Watt College, Edinburgh); David Hughes scholarships (value 50*l*. each), to Mr. R. MacWhirter (Royal Technical College, Glasgow), and to Mr. R. E. Banks (University, Birmingham).

MR. E. S. ELDRIDGE is the first student to pass through the Imperial College of Tropical Agriculture at Trinidad and to secure an appointment in the Colonies. He left on October 25 to take up the position of farm manager in charge of the Empire Cotton Growing Corporation's Cotton Experiment Station in Nyasaland.

PRINTING may now be taken as one of two principal subjects of study for the degree of Bachelor of Commerce of the University of Leeds, and in this connexion the Leeds Central Technical School Printing Department has been affiliated to the University.

FROM the Technical College, Bradford, we have received an illustrated prospectus for 1923–24. The College provides, in addition to part-time evening and day courses, full-time courses covering from one to four years in textile industries, chemistry, dyeing, engineering, physics, and, exceptionally, in biology. The teaching body includes 42 whole-time lecturers. Special courses in advanced study and in training in the methods of research are available, a special physical chemistry laboratory having been recently equipped for research purposes and additional accommodation provided for research in dyeing.

THE annual meeting of the Science Masters' Association will be held on January 3-5, 1924, in the buildings belonging to the Household and Social Science Department, King's College for Women, situated in Campden Hill Road, W., where, in addition to suitable accommodation for lectures, exhibits, etc., there will be residential quarters for about eighty members attending the meeting. The Association has accepted the invitation to participate in a joint conference with the members of the Royal Meteorological Society, and of the Geographical Association, to be held at Birkbeck College, London, on Thursday, January 3. The conference will discuss the present state of knowledge of meteorology and the bearing of the science on cognate school subjects.

AMONGST prospectuses issued by University College, London, for 1923–24, is one of twenty-seven pages, devoted to post-graduation courses of lectures and practical work, including special courses by the new professor of chemical engineering and six courses in the recently established department of "History and Method of Science," by Dr. Charles Singer (general, biological, and anatomical), Prof. Filon (astronomy), and Mr. W. J. Perry (anthropology). In the Rockefeller anatomy building is to be installed, in a room for cinematographic study of animal movements, equipment designed in the Marey Institute of Paris capable of taking 300 photographs a second of moving objects. Post-graduation and research students of the college in 1922–23 numbered 431, including 133 from outside Great Britain.

THE teaching of civics is receiving much attention at present in America. Prof. Edgar Dawson, of Hunter College, New York, has contributed to the Biennial Survey of Education, 1920–22, a chapter (published separately as Bulletin, 1923, No. 23) on "The Social Studies in Civic Education," in which particulars are given of some developments in this field. The new Pennsylvania State course in the social studies aims at giving effect to a conception of "civics" as training in practical good citizenship and, as such, a vital part of the schooling of every child, and even "the only justification of the tax-supported public-school system." It begins with the first year of school life and continues without a break to the end of the twelfth year, being adapted, grade by grade, to the various psychological stages through which the normal child passes. The last three years of the course are primarily intended to train pupils "to investigate, to reason, to compare, to judge." To neglect any longer the provision of specific training in the problems of American democracy, the solution of which will soon be in the hands of the secondary school pupils of to-day, is, in the opinion of the State department, to render a social cataclysm inevitable.

Societies and Academies.

LONDON.

Royal Society, November 1.—E. G. T. **Liddell** and Sir Charles **Sherrington**: A comparison between certain features of the spinal flexor reflex and of the decerebrate extensor reflex respectively. Comparison of the tetani of the knee flexor, evolved by motor nerve stimulation and by reflex excitation, shows somewhat close resemblance between them. A constant difference is the presence of after-discharge in the latter. A further difference frequently found is, the myograph records being isometric for both, a steeper ascent and sharper ascent-plateau turn for the reflex. The reflex tetanus, like the "motor-nerve" tetanus, appears to engage from its very beginning the full quota of the motoneurones that it will at any time under its further continuance engage. The steeper ascent in the reflex is due to after-discharge setting in early, so that some of the motoneurones activated by the reflex cannot respond to the immediately succeeding series of stimuli. Intensity and not duration in the external stimulus is therefore the sole arbiter of the intensity of the reflex tetanus. Similar comparison of the crossed reflex of the knee extensor with the "motor-nerve" tetani of that muscle shows that the reflex tetanus develops much the more slowly, and that the ratio between the tension developed by the reflex contraction to a single shock and that to a serial stimulus is much less than under "motor-nerve" stimulation. The reflex at its outset appears to activate only a small fraction of the quota of motoneurones that it will gradually bring into activity.—J. **Barcroft** and H. **Barcroft**: The blood pigment of Arenicola. The blood pigment of *Arenicola Marina* differs from the hæmoglobin of human blood in certain respects. The α band of the oxy-hæmoglobin is situated 18 Å.U. nearer the violet and the α band of the carbon monoxide hæmoglobin is situated 11 Å.U. nearer the violet than the corresponding human band. The dissociation curves show a greater affinity for both oxygen and carbon monoxide than those of human blood. The affinity for carbon monoxide is about 70 times that for oxygen, as compared with 250 in man and 140 in the mouse. The possibility of a relationship between the position of the bands and the affinity of the pigment for gas is discussed. The main unloading of oxygen from the pigment of Arenicola would appear to be between 1 and 3 mm. pressure. The mean oxygen capacity of the hæmoglobin per gram of Arenicola is about 0·01-0·013 c.c. A comparison between the oxygen capacity of the pigment and the total oxygen consumption of the worm shows that the pigment holds sufficient oxygen to supply the animal for 1-2 hours, and probably acts as a reserve to tide it over the period at low-water when its hole is closed.—T. **Deighton**: The basal metabolism of a growing pig. The basal metabolism of a pig has been measured at various ages from seventy-five days upwards, and it has been shown that in the pig, as in human beings, the metabolism per unit area is greatest in mid-youth. This increase of metabolism in youth seems to be directly ascribable to growth. Metabolism after the ingestion of food reaches a maximum after five hours and then declines. The rationing of pigs for maintenance and growth is discussed, and it is concluded that the curve of rationing for growth and maintenance, without fattening, cannot possibly be a two-thirds power curve.

Physical Society, June 22.—Dr. Alexander Russell in the chair.—F. **Horton**: The excitation and ionisation potentials of gases and vapours. The study of ionisation potentials dates back to the discovery of the phenomenon of the ionisation of gases by collision, but the theoretical importance of a knowledge of the least difference of potential through which an electron must fall in order to acquire sufficient energy to ionise a gaseous atom or molecule on collision with it has greatly increased since the propounding by Bohr of his theory of atomic structure. Bohr's theory predicted the possibility of an atom being excited to emit radiation by the impact of an electron having energy in excess of a definite minimum amount—an amount corresponding to an "excitation" potential less than that required for ionisation. The experimental methods of investigation may be divided into two classes: (1) Those depending on the detection of the loss of energy by the colliding electron; (2) those depending on the detection of the radiation or ionisation resulting from the collisions.

Royal Meteorological Society, October 17.—Dr. C. Chree, president, in the chair.—Sir Napier **Shaw** and D. **Brunt**: Towards a basis of meteorological theory: thirty-nine articles of condition for the middle atmosphere. The propositions refer to the "middle layers" of the atmosphere, or those from 4 to 8 kilometres above mean sea-level; that is, the region lying above the effects of the friction of the earth's surface and below the stratosphere. Owing to the normal increase of potential temperature with height, the middle atmosphere is possessed of resilience and may be regarded as made up of separate aerospheres or horizontal layers which are thermally and therefore dynamically distinct. Air will not pass from one aerosphere to another without some internal source of energy, but there is no resilience for horizontal motion within an aerosphere. That a wide field for discussion is opened is evident from quotation of No. 6 as an example: "The chief effective cause of the general circulation between the equator and the poles and the correlated circulation round the poles is the cooling of the slopes and plateaux of high land in the polar regions."

Royal Microscopical Society, October 17.—Prof. F. J. Cheshire, president, in the chair.—W. F. **Charles**: Peculiarities in the development of the ant's foot. On the inside of the lower palate of the snapdragon, and surrounding the base of the stamens, there is a series of glandular hairs containing a viscous fluid; but these capitate hairs cannot be ruptured by the ordinary claws of the insect. Within the pulvillus of each foot of ants found on snapdragon there appears to be a minute pair of forcep-like claws, developed expressly to enable the insect to grasp and pull itself along hairy surfaces. These claws were sufficiently sharp to puncture certain minute depressions upon the surface of the glandular hairs, releasing the viscous fluid and entangling the ant. The depressions on the hairs, which are covered with one epidermis only, appear to facilitate the rupture.—M. T. **Denne**: A new variable light screen for use with the microscope. The instrument consists of a cylindrical cell provided with an end plate of glass, and a piston sliding within it bearing a second glass plate arranged so that adjustment with respect to the fixed plate may be effected by a high-pitch screw and nut combined with worm gearing. A coloured or neutral-tinted fluid can be introduced between the plates. With stained preparations, the screen permits the gradual intensification of the image of certain elements at the expense of others; with unstained preparations, it gives increased visibility, while dark ground effects are distinctly improved. The range given is from total transmission to nearly extinction of the incident beam.

Industrial Applications Section, October 24.—Prof. F. J. Cheshire, president, in the chair.—Marie C. **Stopes**: The microscopy of recent coal research. Early workers like Dawson and Huxley tended to treat "coal" as if it were a uniform substance. Hence arose disputes, and apparent contradictions, one demonstrating that "coal" was made of spores, others saying that "coal" was made of wood, others of bark. Recent work has shown differences between the finer bands even in the same lump of coal, where only a few millimetres apart one zone may show a preponderance of spores, another a preponderance of leaf or stem tissue, and another a uniform glue-like texture. The four main types composing bituminous coal are fusain, durain, clarain, and vitrain. Prof. Seyler has shown similar zones in anthracite by an opaque method of examination by reflected light.

Zoological Society, October 23.—Dr. A. Smith Woodward, vice-president, in the chair.—E. A. **Spaul**: Experiments on acceleration of metamorphoses of frog-tadpoles by injection of anterior-lobe pituitary-gland extract and iodine.—A. **Subba Rau** and P. H. **Johnson**: Observations on the development of the sympathetic nervous system and suprarenal bodies in the sparrow.—H. C. **Abraham**: A new spider of the genus Liphistius from the Malay Peninsula, and some observations on its habits.—Mr. A. **Smith**: A review of the lizards of the genus Tropidophorus on the Asiatic mainland.—J. G. H. **Frew**: On the larval anatomy of the gout-fly (*Chlorops taeniopus* Meig.) and two related acalyptrate muscids, with notes on their winter host-plants.—A. **Loveridge**: (1) Notes on mammals collected in Tanganyika Territory, 1920–1923. (2) A list of the lizards of British East Africa (Uganda, Kenya Colony, Tanganyika Territory, and Zanzibar), with keys for the diagnosis of the species.

EDINBURGH.

Royal Society, October 22.—F. O. **Bower**: Remarks on the present outlook on descent. At the moment we seem to have arrived at a phase of negation in respect of the achievements of phyletic morphology. So far from presenting a tree with a single trunk, the results of comparison offer us what appears little better than a bundle of sticks. The prospects appear depressing to young aspirants, and it is said that phyletic morphology leaves them cold. But this depends very largely upon the mode of presentment. How, then, are we to proceed in inquiry as to the origin of living things? Surely by a continued study of morphology in its broadest sense. Mr. Tansley, in his address to the British Association at Liverpool, advocated the study of "process of development," that is, physiological inquiry: but he rightly recognises how "process and structure continually act and interact." Structure may be held as the record of process. Any school based primarily on "process" and with "record" relegated to the background might turn out good statisticians, but it would probably fail in converting them into historians. Provided, however, that the study of "process" and "record," that is, of physiology and morphology, be co-ordinated, all may be well with the future of phyletic morphology.

MANCHESTER.

Literary and Philosophical Society, October 23.—H. **Clay**: The economic aspect of the Ruhr problem. The Ruhr is the richest coalfield in Western and Central Europe. Before the War, its output was 60 per cent. of the coal and 80 per cent. of the coke output of Germany; it was the chief centre of the steel industry and the chief source of the coal-tar used by the dye industry and of sulphate of ammonia used in agriculture. Territorial changes under the Treaty have enhanced the relative importance of the Ruhr in Germany's national economy. The occupation by the French, coupled with passive resistance, rapidly reduced the economic activity of the Ruhr. Reparations deliveries of coal almost ceased, and 46 French blast-furnaces out of 116 were damped down between January and April. The Ruhr population was maintained by subsidies from Berlin. The dislocation of industry caused by the separation of the Ruhr and the demoralisation caused by the depreciation of the currency have steadily reduced the efficiency of German industry, until it can no longer produce at world-prices. Unemployment is growing; it is certain to increase if the Berlin (or any other) Government succeeds in floating a new, stable currency and checking inflation. It is unlikely that any German Government will be in a position to pay any reparations, so far ahead as it is practicable to look. The French are unlikely to gain any economic benefit from their occupation of the Ruhr. The policy, so far as its objects were economic, has paid insufficient regard to two fundamental truths; first, that the wealth of a country is not a stock of goods that can be seized, but the output of an organisation that continues only so long as the organisation functions; and, second, that the direction and activity of the industrial organisation responds only very slowly and incompletely to political dictation.

SHEFFIELD.

Society of Glass Technology, October 17.—A. R. **Sheen** and W. E. S. **Turner**: The effect of titania on the properties of glass. Batches were calculated on the basis of the formula, $6SiO_2$, xNa_2O, $yTiO_2$, where $x+y=2$. The first six members of this series gave glasses readily; *i.e.* where the value of y varied from 0·1 to 0·6. Above 0·8 (*i.e.* 13 per cent. TiO_2) it was found difficult to melt the glass at 1400° C. When compared with the corresponding lime and magnesia glasses, the titania-containing glasses had somewhat lower annealing temperatures, durability similar to that of magnesia glasses, and thermal expansion slightly less than that of lime glasses. Heat-resisting properties were also indicated.—A. **Cousen**: The estimation of selenium in glass. Twenty grams of finely powdered glass were dissolved slowly in hydrofluoric acid and, after standing in the cold, the products of decomposition, with the exception of selenium, were dissolved by pouring into excess of boiling water. The selenium itself was filtered off on a filter pulp pad in a Gooch crucible. From the pad the selenium was removed by treating with a dilute chlorine solution (about 1/300 N). To the filtered solution was added 1 c.c. of 5 per cent. gum arabic and 5 c.c. of ½ per cent. phenyl hydrazine hydrochloride, the whole being made up to 50 c.c. Colloidal selenium was obtained, a yellow colour slowly developing. After half an hour this colour was matched against a standard solution of sodium selenite similarly treated.

PARIS.

Academy of Sciences, October 15.—M. Albin Haller in the chair.—A. **Lacroix**: The notion of doliomorph type in lithology. The term "doliomorph" is applied to lithologic types, which, from the chemical point of view, do not correspond with their mineralogical composition. According to the usual mode of expression, quartziferous rocks, rocks with free silica,

acid rocks are regarded as synonymous. It is shown that this equivalence is not always legitimate. In the new classification, doliomorph types are not classed with rocks of the same qualitative mineralogical composition, but with those of the same chemical composition, with some of which they are heteromorphs.—Jean **Perrin**: Radiochemistry and fluorescence. Results of measurements on the disappearance of "new methylene blue" under the action of light, completing the theory proposed in an earlier communication (*C.r.*, 1923, p. 612).—L. **Joubin**: The meeting of the International Council for the Exploration of the Sea, held at Paris. An account of the work done by the committees.—V. **Grignard**, J. Dœuvre, and R. **Escourrou**: The constitution of natural methylheptenone. The ketone exists in two isomeric forms, and this has given rise to some uncertainty regarding its constitution. The authors have applied the method of oxidation by ozone and have estimated the oxidation products, formaldehyde (with formic acid and carbon dioxide) characterising the α-form, acetone the β-form. Methylheptenones from four different sources were examined by this method, and it was shown that the natural ketone is a mixture of both forms; the α-form is in the smaller proportion, about 25 per cent.—Ervand **Kogbetliantz**: The unicity of trigonometrical series.—F. H. **van den Dungen**: Integral equations, with several parameters and their technical applications.—N. Vasilesco **Karpen**: The mechanism of hovering flight.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the third quarter of 1923. Owing to bad weather, observations were possible on only sixty-two days during the quarter. The usual tabular summary is given.—Mlle. **St. Maracineanu**: A method of measurement suitable for a strong radiation. The method described is applied to the cases of polonium and actinium.—Claude **Bonnier**: Aqueous solutions of ammonium bicarbonate. When ammonium bicarbonate is dissolved in water in a closed vessel, there is evolution of gas, and pressure is set up. In the present note the influence of concentration of the solution and of the ratio of the volumes of the liquid and gas phases on the pressure is studied, and the experimental results expressed in the form of curves.—M. **Bourguel**: The preparation of true acetylene hydrocarbons by sodium amide, starting with 2-3-dibrompropylene. Hexine and cyclohexylpropine. The dibrompropylene, $CH_2Br . CBr : CH_2$ (prepared from allyl bromide), is treated with a magnesium alkyl bromide, RMgBr, under conditions exactly defined, giving the bromide, $R . CH_2 . CBr : CH_2$, and hydrogen bromide is removed from this by treatment with sodium amide. The hydrocarbons obtained are true acetylenes, and the method is a general one.—Raymond **Delaby**: The catalytic dehydration of ethylglycerol.—J. F. **Durand**: Double decompositions, in aqueous solutions, between metallic acetylides and salts.—Jean **Bordas**: A cause of error in the Iodlbauer method for the estimation of total nitrogen. The presence of tannins in substances analysed by this method causes errors due to loss of nitrous fumes.—P. **Gaubert**: The planes of Grandjean.—Emile **Belot**: A form of latent vulcanism in connexion with earthquakes and tidal waves. The experimental reproduction of a tidal wave.—E. **Rothé**: The earthquakes observed in France in the course of the year 1922. Fourteen shocks were felt during the year, a number much higher than the average. Details are given of each.—René **Souèges**: The embryogeny of the Joncaceæ. The development of the embryo in *Luzula Forsteri*.—V. **Lubimenko**: The influence of leaf wounds on the production of dry substance in green plants.—E. **Lesné** and M. **Vagliano**: The differentiation of vitamin A and the factor preventing rickets.—F. **Vincens**: A disease of the bee (muscardine) due to *Beauveria Bassiana* produced experimentally in bees. This fungus, when present in the food, is readily communicated to bees, causing death within six days.—E. **Roubaud** and J. **Descazeaux**: A bacterial agent pathogenic to the common fly, *Bacterium delendæ-muscæ*. This new coccobacillus was isolated from a spontaneous infection which occurred during the study of *Stomoxys calcitrans*. Details are given of its morphology and culture. The domestic fly is very resistant to bacterial infection, and the fact that it is attacked and killed by the new type is of great interest.—A. T. **Salimbeni** and Y. **Kermorgant**: A new spirochæte met with in the blood of patients suffering from measles.—Fernand **Wyss**: Variation in the morphology and acido-resistance of the human tubercle bacillus under the influence of a saponine.

Official Publications Received.

Memoirs of the Department of Agriculture in India. Botanical Series Vol. 12, No. 2. 1: History of the Operations against Bud-rot of Palms in South India; 2: Inoculation Experiments with *Phytophthora palmivora* Butl., on *Borassus flabellifer* Linn., and *Cocos nucifera* Linn. By W. McRae. Pp. iv+21-70. Botanical Series, Vol. 12, No. 3: Studies in Inheritance in Cotton, I. History of a Cross between *Gossypium herbaceum* and *Gossypium neglectum*. By G. L. Kottur. Pp. iv+71-133. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 1.4 rupees; 2*s*., each.

Bulletin of the Imperial Institute. Vol. 21, No. 1: Report on the Operations of the Imperial Institute. Pp. 290+iv. (London: John Murray.) 3*s*. 6*d*. net.

Report of the Council of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, intended to be presented at the Annual Meeting of the Society, October 30th, 1923. Pp. 33. (Newcastle-upon-Tyne.)

Canada. Department of Mines: Geological Survey. Summary Report, 1922, Part A. Pp. 145A. Summary Report, 1922, Part D. Pp. 98D. (Ottawa: F. A. Acland.)

Canada. Department of Mines: Geological Survey. Memoir 133, No. 114 Geological Series: The Southern Part of the Sydney Coal Field, Nova Scotia. By A. O. Hayes and W. A. Bell. Pp. 108. Memoir 134, No. 115 Geological Series: Brockville-Mallorytown Map-area, Ontario. By J. F. Wright. Pp. 63+4 plates. (Ottawa: F. A. Acland.)

Canada. Department of Mines: Victoria Memorial Museum. Bulletin No. 37, Anthropological Series, No. 8: An Album of Prehistoric Canadian Art. By Harlan I. Smith. Pp. iii+195. (Ottawa: F. A. Acland.) 50 cents.

Departement van Landbouw, Nijverheid en Handel: "'S Lands Plantentuin" (Jardin Botanique de Buitenzorg). Treubia: Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 3, Livraison 1. Pp. 126. Vol. 3, Livraison 2. Pp. 127-242. Vol. 3, Livraison 3-4. Pp. 243-432. (Buitenzorg: Archipel Drukkerij.)

University College of the South-West of England: Session, 1922-23. List of Members of the Court of Governors, Annual Report of the Council, Annual Report of the Senate, Accounts. Pp. 57. (Exeter.)

County Council of the West Riding of Yorkshire. Nineteenth Annual Report of the Education Committee, presented at a Meeting of the West Riding County Council on 10th October 1923. Pp. 54. (Wakefield.)

Lawes Agricultural Trust: Rothamsted Experimental Station, Harpenden. Report 1921-22, with the Supplement to the "Guide to the Experimental Plots" containing the Yields per Acre, etc. Pp. 105. (Harpenden.) 2*s*. 6*d*.

The National Institute of Agricultural Botany. Fourth Report and Accounts, 1922-23. Pp. 16. (Cambridge.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 3, 1921. IV: Meteorologiska iakttagelser i Sverige, Band 63 (IV: Observations météorologiques suédoises, Vol. 63). Pp. xi+181. (Uppsala: Almquist & Wiksells Boktryckeri A.-B.) 10 kronor.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 2, No. 1: Vegetationens Årliga utvecklingsgång i Svealand. By H. Wilh. Arnell. Pp. 80. (Stockholm.) 4 kronor.

The Indian Forest Records. Vol. 10, Part 1: The Constituents of some Indian Essential Oils. By John Lionel Simonsen. Part 11: The Essential Oil from the Leaves of *Cupressus torulosa*, Don. Pp. 10. (Delhi: Government Central Press.) 3 annas.

Tide Tables for the Eastern Coasts of Canada for the Year 1924: including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits; and Information on Currents. (Issued by the Tidal and Current Survey in the Department of Marine and Fisheries of the Dominion of Canada.) Twenty-eighth Year of Issue. Pp. 75. (Ottawa: F. A. Acland.)

Tide Tables for the Pacific Coasts of Canada for the Year 1924: including Fuca Strait, the Strait of Georgia, and the Northern Coast: with Data for Slack Water in the Navigable Passes and Narrows, and Information on Currents. (Issued by the Tidal and Current Survey in the Department of Marine and Fisheries of the Dominion of Canada.) Twenty-fourth Year of Issue. Pp. 75. (Ottawa: F. A. Acland.)

Smithsonian Institution: Bureau of American Ethnology. Bulletin 79:

Blood Revenge, War, and Victory Feasts among the Jibaro Indians of Eastern Ecuador. By Rafael Karsten. Pp. vii+94+10 plates. 60 cents. Bulletin 40: Handbook of American Indian Languages. By Franz Boas. Part 2. With Illustrative Sketches by Edward Sapir, Leo J. Frachtenberg, and Waldemar Bogoras. Pp. v+903. (Washington: Government Printing Office.)

Iowa Geological Survey. Vol. 28: Annual Reports, 1917 and 1918, with Accompanying Papers. Pp. viii+558. (Des Moines.)

Smithsonian Institution: United States National Museum. Bulletin 125: North American Later Tertiary and Quaternary Bryozoa. By Ferdinand Canu and Ray S. Bassler. Pp. vii+302+47 plates. (Washington: Government Printing Office.) 75 cents.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 23, Part 3: Trees and Shrubs of Mexico (Oxalidaceæ-Turneraceæ). By Paul C. Standley. Pp. iii+517-848+v-xxviii. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 744: The Lime Belts of Massachusetts and Parts of Eastern New York and Western Connecticut. By T. Nelson Dale. Pp. vi+71+8 plates. 80 cents. Bulletin 751-B: Progress Report on a Subsurface Study of the Pershing Oil and Gas Field, Osage County, Oklahoma. By W. W. Rubey. Pp. iv+23-70+8 plates. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 501: Surface Water Supply of the United States, 1919-1920. Part 1: North Atlantic Slope Drainage Basins. Pp. 330+2 plates. 30 cents. Water-Supply Paper 510: Surface Water Supply of the United States, 1919-1920. Part 10: The Great Basin. Pp. vi+348+2 plates. 30 cents. Water-Supply Paper 512: Surface Water Supply of the United States, 1919 and 1920. Part 12: North Pacific Slope Drainage Basins. A: Pacific Basins in Washington and Upper Columbia River Basin. Pp. v+262+2 plates. 25 cents. (Washington: Government Printing Office.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1335: Controlling the Gypsy Moth and the Brown-Tail Moth. By A. F. Burgess. Pp. ii+68. Farmers' Bulletin No. 1349: Increasing the Potato Crop by Spraying. By F. H. Chittenden and W. A. Orton. Pp. ii+22. Farmers' Bulletin No. 1352: The Tobacco Flea-Beetle in the Southern Cigar-Wrapper District. By F. S. Chamberlin and J. N. Tenhet. Pp. ii+10. Farmers' Bulletin No. 1353: Clothes Moths and their Control. By E. A. Back. Pp. ii+28. (Washington: Government Printing Office.) 5 cents each.

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 27: Hampton Normal and Agricultural Institute; its Evolution and Contribution to Education as a Federal Land-Grant College. Prepared under the Direction of Walton C. John. Pp. v+118+13 plates. 25 cents. Bulletin, 1923, No. 30: An Americanization Program. By E. J. Irwin. Pp. iii+60. 10 cents. Bulletin, 1923, No. 33: Educational Hygiene. By Willard S. Small. Pp. iii+36. 5 cents. Bulletin, 1923, No. 39: Consolidation and Transportation Problems; Report of the Second National Conference on Consolidation of Rural Schools and Transportation of Pupils, Cleveland, Ohio, February 26, 1923. By J. F. Abel. Pp. 22. 5 cents. (Washington: Government Printing Office.)

R. Ufficio Centrale di Meteorologia e Geodinamica, Roma. Notizie sui terremoti osservati in Italia durante l' anno 1911. Compilate dal Prof. Giuseppe Martinelli. (Appendice al Vol. 18, 1914, del "Bollettino della Società Sismologica Italiana.") Pp. 588. (Roma.)

Department of Scientific and Industrial Research: Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1922, with Report of the Geological Survey Board and Report of the Director. Pp. iii+164. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.) 4s. net.

Diary of Societies.

MONDAY, NOVEMBER 12.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Discussion of two papers on Isostasy: Doubts on Terrestrial Isostasy, Prof. A. Alessio; Abnormal Densities in the Earth's Crust disclosed by Analysis of Geodetic Data, W. Bowie.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Prof. T. P. Nunn: The Philosophy of Gentile.

ROYAL SOCIETY OF ARTS, at 8.—S. H. Davies: The Cultivation of Cocoa in British Tropical Colonies. (Cantor Lecture.)

FARADAY SOCIETY (at Chemical Society), at 8.—A. J. Allmand and A. N. Campbell: The Electrodeposition of Manganese.—S. Glasstone: The Cathodic Behaviour of Alloys. Part I. Iron-Nickel Alloys.—A. L. Norbury: The Volumes occupied by the Solute Atoms in Certain Metallic Solid Solutions and their Consequent Hardening Effects.—J. B. Firth and F. S. Watson: The Catalytic Decomposition of Hydrogen Peroxide Solution by Blood Charcoal.—E. E. Walker: The Properties of Powders. Part VIII. The Influence of the Velocity of Compression on the Apparent Compressibility of Powders.—L. Anderson: (*a*) An Investigation of Smoluchowski's Equation as applied to the Coagulation of Gold Hydrosol; (*b*) The Effect of Sucrose on the Rate of Coagulation of a Colloid by an Electrolyte.—H. H. Paine and G. T. R. Evans: A Method of measuring the Rate of Coagulation of Colloidal Solutions over Wide Ranges.—J. A. V. Butler: Studies in Heterogeneous Equilibrium. Part I.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 8.30.—Prof. L. S. Dudgeon: Presidential Address.—Dr. E. C. Faust: Some Biological and Practical Aspects of Schistosomiasis in China.—Miss G. Le Bas: The employment of Fasciola Hepatica as a substitute for infected Snails' Liver for the Fairley reaction in Bilharziasis.

TUESDAY, NOVEMBER 13.

INSTITUTE OF HYGIENE, at 3.30.—Dr. A. M. Hewat: Pure Food Supplies.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—A. Millar: Galician-Canadian Pole Tool Fishing Methods.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Adjourned Discussion on Paper by H. J. Young and E. Wood, on Cast Iron for Marine Engine Castings from the Metallurgical and Engineering Points of View.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. C. Banfield: Some Interesting Optical Munitions from the Mechanical Point of View.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—T. M. Offord: A Talk on Spiders.—J. Wilson: Report on Proceedings of the British Association.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Reports on Progress during the Vacation and Developments in Lamps and Lighting Appliances.

WEDNESDAY, NOVEMBER 14.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 6.30.—L. Murphy: The Misuse of the Internal Combustion Engine and Suggestions for its more efficient application.

INSTITUTION OF CHEMICAL ENGINEERS (at Engineers' Club, Coventry Street), at 7.30.—M. B. Donald and R. D. Hunneman: A Study of the Conditions of Constant Rate of Flow in Filter Presses.—M. B. Donald and C. W. Tyson: A Study of the Absorption Tower.

ROYAL SOCIETY OF ARTS, at 8.—E. Belin: The Electric Transmission and Reproduction of Writing, Designs and Photographs without Wires.

THURSDAY, NOVEMBER 15.

ROYAL SOCIETY, at 4.30.—Sir William Bragg and Prof. G. T. Morgan: Crystal Structure and Chemical Constitution of Basic Beryllium Acetate and Propionate.—G. I. Taylor: Experiments on the Motion of Solid Bodies in Rotating Fluids.—L. C. Jackson: Investigations on Paramagnetism at Low Temperatures.—L. C. Jackson and Prof. H. Kamerlingh Onnes: The Magnetic Properties of Some Paramagnetic Double Sulphates at Low Temperatures.—H. H. Potter: Some Experiments on the Proportionality of Mass and Weight.—*To be read in title only*:—Lord Rayleigh: Further Studies on the Glow of Phosphorus and its Extinction by Moist Oxygen.—Prof. H. A. Wilson: An Experiment on the Origin of the Earth's Magnetic Field.—Dr. H. Robinson: The Secondary Corpuscular Rays produced by Homogeneous X-Rays.—Lt.-Col. J. W. Gifford, with an Introduction by Prof. T. M. Lowry: Some Refractive Indices of Benzene and Cyclohexane.—J. A. V. Butler: Note on the Significance of the Electrode Potential.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—H. R. Ricardo: The Thermodynamics of Aircraft Engines.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

CHEMICAL SOCIETY, at 8.—

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W. 1), at 8.15.—Preceded by a Demonstration at 7.45 of various Spirochætes.—Dr. J. Gilks: Yaws in Kenya Colony.

FRIDAY, NOVEMBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—W. J. Kearton: The Possibilities of Mercury as a Working Substance for Binary Fluid Turbines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. V. Lyle: Realism and Reality.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Industry Club, 2 Whitehall Court), at 8.—Prof. J. W. Hinchley: A New Source of Potash, and its Industrial Exploitation.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. S. Harrison: Fashion amongst Savages.

TUESDAY, NOVEMBER 13.

WESTFIELD COLLEGE, at 5.15.—Mrs. Tufnell: A Glimpse of Czechoslovakia.

UNIVERSITY COLLEGE, at 5.30.—W. J. Perry: The Aims of Anthropology.

WEDNESDAY, NOVEMBER 14.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—W. B. Smith: The Extravagance of a Smoke-polluted Atmosphere.

UNIVERSITY COLLEGE, at 5.30.—Sir Jagadis C. Bose: The Physiology of Photosynthesis.

THURSDAY, NOVEMBER 15.

LONDON SCHOOL OF ECONOMICS, at 5.30.—F. Pick: The Problem of London Traffic: The Objects and Effects of Traffic Control.

FRIDAY, NOVEMBER 16.

IMPERIAL INSTITUTE, at 5.30.—E. Audra: France and Europe. (League of Nations Union Lecture.)

KING'S COLLEGE, LONDON, at 5.30.—C. E. M. Joad: The Philosophical Background of Music and Poetry: The Function of Music.

ROYAL SOCIETY OF ARTS, at 8.—Major H. Barnes: Hygiene and Architecture: Preventive Hygiene—Health and the Building. (Chadwick Lecture.)

SATURDAY, NOVEMBER 17.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—G. Morris: The Prehistoric Survey of Selborne.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—S. H. Warren: The Cave-Paintings of Stone Age Man in Europe.

NATURE

SATURDAY, NOVEMBER 17, 1923.

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Small-pox and Vaccination.[1]

THERE is something refreshingly interesting in the new practice of arranging for the education of our legislators by means of addresses by experts on subjects in which Parliament is concerned, and Dr. McVail's recent address may be regarded as an admirable example of good that may thus be achieved.

Small-pox has, however, more than a practical interest. Next perhaps to influenza it is a disease the epidemiology of which has more scientific interest than that of any other disease; and it is unique in being a disease in which pandemic outbreaks,—invading mankind at irregular intervals in an unexplained manner,—can be entirely and have been largely controlled by vaccination and by the public health measures which circumscribe the action of the virus of small-pox.

Small-pox furthermore is a disease which in recent years, and probably also in the past and even in the pre-vaccination period, has prevailed as two different varieties. One no physician could cure, and one no malapraxis could render fatal to the patient. Thus, in ten cities in the United States, of every 100 persons attacked by small-pox in 1922, 28·4 died, whereas in 1920 the fatality rate in the same cities was only 0·2 per cent. Evidently we are dealing in this experience with two diseases or with two definite mutations of the same disease. That the second is the right explanation is shown by the fact that vaccination protects against the mild as well as against the severe small-pox. In recent years our knowledge of the milder variety of small-pox has greatly increased. It has prevailed widely throughout America, spreading from the Southern Atlantic across to the Pacific. It has invaded Great Britain, and the recent mild outbreak of small-pox in Gloucester and the Midlands belongs to this type.

The mild character of the small-pox in unvaccinated persons in the recent outbreak has raised doubts in some minds as to the necessity for vaccination; but the following facts show the fallacy of this view. First, vaccination protects against the mild as against the severe small-pox. Secondly, there is a difference in degree of severity of attack,—on a lower grade than with the more serious type of disease,—of vaccinated and unvaccinated respectively; and thirdly, although details of current outbreaks are not yet available, it will doubtless be found that, as in the mild outbreaks of a few years ago, unvaccinated are attacked at a much earlier age than the vaccinated.

Nevertheless, if it could be certified that all subsequent outbreaks of small-pox would be of this unusual

[1] *The Fight against Disease.* Smallpox and Vaccination, by Dr. John C. McVail. An Address to Members of the House of Commons in Committee Room No. 14, July 25, 1923. The Minister of Health in the chair. (London: Macmillan and Co., Ltd.) Price 6*d.*

mild type, the necessity for vaccination would be less urgent than it now is. It might be limited to persons exposed to actual infection, or living in the neighbourhood of outbreaks. No such assurance can be given. In New York, both types of small-pox have been known to prevail at the same time. Our knowledge of the causation of variations in type of disease and of the correlative changes in virulence of virus and in fatality of attack is almost nil; and in practice we must be guided by the experience of the past, which shows that Great Britain is liable to be invaded at intervals not only with a relatively innocent type of small-pox coming from the west, but also with a virulent type, hailing from Asia and Africa. We cannot afford to relax our sanitary precautions against both types of the disease, nor can we afford to neglect the artificial immunity against attack which vaccination affords.

Whether in the future the secrets of the origin of the milder type of small-pox will be revealed, or whether it may be practicable to isolate the virus of small-pox or of this virus as organically modified in vaccine lymph, and afford a method of vaccination on a completely scientific basis, one cannot prophesy; but meanwhile the preventive measures already in our hands must be utilised to their fullest extent, and these enable us to control with absolute certainty the epidemic course of small-pox in its intermittent raids on mankind. Of no other disease can this be said with equal certainty, except in regard to certain tropical diseases, and to such water-borne diseases as typhoid fever and cholera. In a few years we may find that the same confident statement can be made in respect of diphtheria, if parents can be educated to realise the practicability of testing their children's susceptibility to this disease by what is known as the Schick test, and to appreciate the equal practicability of securing artificial immunity by means of toxin-antitoxin.

Meanwhile we hope that Dr. McVail's pamphlet will receive wide circulation. It establishes very clearly and succinctly the propositions which it sets out to prove, namely, that small-pox is worth preventing, that it can be prevented by vaccination, that it cannot be prevented without vaccination, and that properly conducted vaccination is very safe.

A National Education Week.

THE institution of a national "Education Week" has been officially blessed by the new President of the United States in an impressive Proclamation in which, after reciting the benefits of education, especially adult education, Mr. Coolidge declares an annual observance of Education Week to be desirable "in order that the people may think on these things." He proclaims the week beginning November 18 as the Education Week for 1923, and recommends that State and local authorities co-operate with the civic and religious bodies to secure its most general and helpful observance.

Last year, President Harding and 42 State Governors issued proclamations or statements on the subject, and the week was said to have been a gigantic success. It was estimated that the campaign reached 50 million people, including 20 million in motion-picture houses. It is probably due largely to the enthusiasm aroused by these annual campaigns that the membership of "parent-teacher" associations increased in two years from 189,000 to 500,000. Reciprocally the associations contribute enormously to the success of the Education Weeks. Without some such machinery the effervescence of the Education Week might subside without leaving any permanent beneficial results. The efficacy of this kind of propaganda depends partly on the interest already taken by the general public in education and partly on their suggestibility, and what Americans call "the magic of 'together'."

In England a notable success was achieved last year by the West Ham Education Week. This year local weeks have been organised in Nottingham, Hastings, Warrington, and Gillingham, and probably elsewhere. Should an attempt be made to organise such observances on a national scale in England, experience gained in organising the National Health Weeks initiated in 1913 by the Agenda Club might afford useful precedents. The striking success of the Education Exhibitions organised in London in connexion with the Imperial Education Conference last July by the Board of Education and the London County Council's Education Committee indicates that a national Education Week, if properly managed, would appeal to a very large public. Many recent developments in the schools, such as the increased attention paid to the teaching of science, drawing, manual training, dancing and other physical training, dramatic performances, Montessori methods, the use of "educational" films, and so on, lend themselves readily to exhibitional purposes. On the other hand, there are reasons for believing that too little effort has been made to cultivate close relations between the schools and the communities they serve.

During the past twenty-five years the achievements of science have been greater than in any previous similar period of time in the history of the world, but less is done with the object of enlightening the public regarding them than in the Victorian era. A Science Week would do much to promote public appreciation of the worth of science, and among other beneficial results that might be looked for from such an enterprise is a much needed stimulation of interest in University Extension work in the field of science.

Carl von Linné.

Linnæus (afterwards Carl von Linné): the Story of his Life, adapted from the Swedish of Theodor Magnus Fries, Emeritus Professor of Botany in the University of Uppsala, and brought down to the Present Time in the Light of Recent Research. By Dr. Benjamin Daydon Jackson. Pp. xv + 416 + 8 plates. (London: H. F. and G. Witherby, 1923.) 25*s.* net.

THOSE who admire the work of Linnæus were indebted to Prof. Th. M. Fries in 1903 for a new life of his great predecessor at Uppsala. Members of the Linnean Society of London now have to thank their general secretary for an English epitome of the Swedish work.

Linnæus accounted himself "a born methodizer." His contemporaries thought so too, and this belief is entertained still, both by those who appreciate and by those who belittle what Linnæus accomplished. But while his work justifies his own estimate, that estimate does him less than justice. Linnæus failed to foresee that in one country dialectic aptitude would eventually so affect ability to grasp principles as to induce discrimination between "pure mathematics, astronomy or any branch of science which aims merely at describing, cataloguing or systematizing," and philosophic activities that afford scope for "experimental research." He could scarcely have predicted that, in another country, the tendency to see ahead would so affect ability to look around that Linnæus could no longer be considered a botanist.

The Linnæus of the "Lachesis Lapponica" was a great naturalist of uncommon judgment, with an inborn capacity for observation. The Linnæus of the "Musa Cliffortiana" had a decided capacity for physical experiment, which later tasks hindered him from exercising to the full. Linnæus regarded the improvement of natural knowledge for use as important as its improvement for discovery; in his travels as a student and his later journeys on public commission, economic and scientific questions received equal attention. His biological study revealed the defects of received classifications; his economic instinct suggested the need for reform; his philosophic interest in the "mystery of sex" supplied the means.

Linnæus found the basis of method to be the recognition of natural kinds; the practical segregation of these into sorts and strains, and their theoretical aggregation into septs and clans. These tasks may proceed either by synopsis, which involves arbitrary dichotomy, or by system, which entails considered arrangement. Synthetic in mind, Linnæus thought system, however crude, preferable to synopsis, however complete, and so improved a by-product of scientific investigation as to substitute order for chaos in the domain of Nature. Linnæus did not claim that the system he outlined on May 11, 1731, when he was only twenty-four, added to real knowledge; its purpose was to serve economic ends by rendering real knowledge usable. Those who decry and those who excuse the artificial nature of his sexual system, alike overlook what Linnæus taught. His artificial higher groups were meant to serve as substitutes for natural ones, only until the latter had all been detected. Like his precursors, Morison and Ray, Linnæus strove to decipher the real system of Nature. Extending their studies, he laid the foundation of that system, and only refrained from applying it in practice lest those who improve natural knowledge for use be thereby deprived of a thread to guide them through the maze of things. Others have followed Linnæus along the path opened up by Morison, and have devised systems as workable as the pragmatic method of Linnæus. Modern students of the "mystery of sex" are, however, at times inclined to think these "natural" systems almost as "artificial" as the Linnean "sexual system."

Until Bauhin in 1623 enumerated the plants he knew with reference to their names, it was usual for those who reproduced old descriptions to devise fresh designations. Linnæus gave stability to Bauhin's reform when, in 1753, he enumerated the names he knew with reference to the plants concerned. For Linnæus the naming of kinds was a responsibility so grave that he made the genus "a thing of dignity." The name of a sort was, for him, necessarily that of its kind combined with a differential statement, and the relationship of a specific to its generic name was that of the bell to its clapper or the clapper to its bell. The purpose of scientific nomenclature is so akin to that of heraldic achievement as to suggest that the use by Linnæus of "trivial" epithets, ancillary to yet distinct from specific names, may have been taken from the older and rigorously disciplined technology which employs "crests" as ancillary to, although independent of, "arms." While advantageous in applied study, these "trivial" terms have proved a mixed blessing in descriptive work. Linnæus was himself so immune against both the juvenile tendency to confuse means with ends, and the adult liability to care more for names than things, that he did not foresee the later retreat from philosophical positions secured by him for science. Histories of natural "families" now supplant accounts of "genera"; now, the "trivial" terms designed by him as aids in economic work are often mistaken for specific names and sometimes treated as entities apart. The efforts to stabilise nomenclature, which this abandonment of sound scientific principles has entailed, involve results so bewildering that one

fervent hope of the applied worker is the appearance of another Linnæus.

British naturalists who know what Linnæus did will welcome most the possibility now afforded them of realising what Linnæus was. Thanks to the piety of Prof. Fries, our belief in the courage of his youth and the high purpose of his whole career is more than confirmed. We learn with relief that the tales of injustice done to him were never countenanced by Linnæus, and gather with satisfaction that these acts of injustice never occurred. The story of an averted duel was evolved from the inner consciousness of a German admirer after both Linnæus and Rosén were dead. The circumstantial account of his strained relations with Browall is a fable as impossible as it is impertinent. The frigate despatched to recover his collections is a figment of English artistic fancy. If we regret the loss of the legend of the gorse on Putney Heath, we do so less because of the story than because we learn with sadness that Linnæus did not love our nation. We find compensation in this opportunity of seeing ourselves as others see us, and take comfort from the assurance that his feeling was not due to the insular reserve, not to say frigidity, which marked his reception in Great Britain in 1736. The many acts of kindness subsequently done to him by both, effaced from his memory the original misjudgment, by Miller of his capacity, by Dillenius of his aims. What Linnæus was unable either to forget or forgive was that the English should have permitted Sweden to purchase, for the paltry sum of 15*l*., the priceless West Indian collection of Dr. Patrick Browne. Looking back through the mist of years to 1758, we may perhaps pardon the generous indignation of Linnæus at English philistinism. We can at least appreciate his feelings, and if we do not share his anger, this is only because we know that the spirit he disliked is as rampant now as it was when Linnæus lived.

Fortunately, Linnæus was spared the knowledge that this spirit is not peculiar to our nation. Inwoven in the web of his scientific thought we find a silver thread of faith in Divine Providence. But, alongside this, there lay a thread of darker hue. For the guidance of his son, Linnæus noted instances, in his own experience, of "Nemesis Divina." Was the feeling aroused by English disrespect towards the collection of Browne the reflex of a subconscious dread lest like disrespect be shown towards his own? Fate ordained that the collection of Linnæus should come to England, and Sweden knows that it has been guarded here with all the respect and care that Sweden has shown towards the Jamaica collection the study of which caused Linnæus to neglect "friends, relations, house and fatherland." History, for once, can point to a case in which the contemplation of parallel injuries has increased mutual regard, and has helped to cement the ties that link two kindred and friendly nations.

Chemistry of the Metals.

(1) *A Treatise on Chemistry.* By the Rt. Hon. Sir H. E. Roscoe and C. Schorlemmer. Vol. 2: The Metals. New edition completely revised by B. Mouat Jones and others. Part 1. Pp. xv+829. Part 2. Pp. viii+831-1565. (London: Macmillan and Co., Ltd., 1923.) 50*s*. net.

(2) *Metals and Metallic Compounds.* By Ulick R. Evans. In 4 vols. Vol. 1: Introduction, Metallography, Electro-Chemistry. Pp. xii+468. 21*s*. net. Vol. 2: Metals of the "A" Groups. Pp. xi+396. 18*s*. net. Vol. 3: The Transition Elements. Pp. xii+270. 14*s*. net. Vol. 4: Metals of the "B" Groups. Pp. xii+350. 18*s*. net. (London: E. Arnold and Co., 1923.)

(1) THE last revision, in 1913, of volume ii. of Roscoe and Schorlemmer's "Treatise" carried the volume up to the largest convenient dimensions for binding. The present revision has resulted in the separation of the volume into two parts, each containing some 800 pages, as compared with nearly 1000 pages in the volume on the "Non-Metals." Once more the revision has been carried out in such a way as to preserve fully the original character of the work, and many readers would have been disappointed if any other policy had been adopted. On these lines much valuable new information has been included in the volume, which will continue to occupy an unique place in English chemical literature. It is, however, a matter of opinion how long this policy should be continued in view of the increasing extent to which modern inorganic chemistry is being developed on physico chemical lines. Sooner or later, it will probably be necessary to introduce equilibrium-diagrams in the text and to deal with chemical processes in which reversible actions are used on a more definite physico-chemical basis.

The revisers have been perhaps a little too careful in retaining old matter in the text. The full details which are still given of the Leblanc soda process and of the Bessemer process for steel are really of historical interest only now that the last Leblanc plant and Bessemer converter have been shut down. It is a question whether they ought to be retained as a part of the systematic teaching of chemistry merely because a generation will probably elapse before they cease to be the subject of possible questions in examinations.

The crystallographic sections of the book have been fully revised by Mr. Barker; but it is a pity that th

new illustrations are so easily distinguished from the old by the rougher way of reproduction. The spectroscopic sections have not received a similar revision, and do not therefore give a correct impression of the modern position of the subject. Thus the apparatus "best suited to ordinary chemical purposes" is still apparently that of Bunsen, and his recommendations for mapping spectra are retained. Again, modern work on spectral series will obviously occupy an important position in the next edition, but is very barely touched upon in the present issue. The descriptive chemistry is, however, as good as ever, and the new edition can be heartily commended as one of the best available books on this aspect of the science.

(2) Mr. Evans's four volumes on "Metals and Metallic Compounds" cover a few pages less than the two parts of vol. ii. of Roscoe. He has the advantage of starting *de novo* and has made free use of this liberty by developing fully the chemical points that are of special interest to a metallurgist. The book is, however, definitely a chemical rather than a metallurgical treatise, since the compounds of the metals are described as fully as the elements themselves. To one who is interested in the broader aspects of the science, it is nevertheless refreshing to find a chapter of the introduction given up to geo-chemistry. This introduction is followed by chapters on metallography and electro-chemistry, which complete the first of the four volumes.

The systematic description of the individual metals and their compounds in the remaining three volumes is very wisely based upon the long periods rather than the short periods of Mendeléef's classification. In this way the natural sequence of alkalis, alkaline earths, and earths (rare or otherwise) is preserved, while copper is grouped with the heavy metals to which it is closely allied. The "eighth group" metals occupy the third and smallest volume of the series, while the second and fourth volumes deal with the elements which occur in the earlier and later octaves of the long periods, together with their obvious homologues in the two short periods. Throughout these volumes the impression is maintained that the author is a geochemist and a metallurgist as well as a chemist, and that he has an up-to-date knowledge of modern technical operations as well as of pure chemical science. His references to technical and semi-technical literature are likely to prove of special value, since, although literature of this kind may be of relatively transitory importance, it is much less accessible to the ordinary chemical student than the literature of pure chemistry, to which existing text-books form a sufficient guide.

In view of its special characteristics, Mr. Evans's treatise does not enter into direct competition with any other work on chemistry, at least in the English language. It will probably appeal in a special way to chemical students with a leaning towards the practical side of the subject, to metallurgists and to engineers; but it will also serve as a work of reference by means of which chemists in general may trace out items of interest which are not noticed in books of a more conventional type. It can therefore be highly commended as an original work of more than average merit, on the prompt completion of which the author may be congratulated.

Alpine Tectonics and other Problems.

(1) *Die Grundlagen der alpinen Tektonik.* Von Fr. Heritsch. Pp. v+259. (Berlin: Gebrüder Borntraeger, 1923.) 9*s.* 6*d.*

(2) *Geologie von Württemberg nebst Hohenzollern.* Von Prof. Dr. E. Hennig. Erste Lieferung. (Handbuch der Geologie und Bodenschätze Deutschlands.) Pp. iii+216. (Berlin: Gebrüder Borntraeger, 1922.) 8*s.* 2*d.*

(3) *Grundzüge einer vergleichenden Seenkunde.* By Prof. Dr. W. Halbfass. Pp. viii+354. (Berlin: Gebrüder Borntraeger, 1923.) 15*s.* 3*d.*

(4) *Geomorphology of New Zealand.* By Prof. C. A. Cotton. Part 1. Systematic: an Introduction to the Study of Land-forms. (New Zealand Board of Science and Art, Manual No. 3.) Pp. x+462. (Wellington, N.Z.: Dominion Museum, 1922.) 22*s.* 6*d.*; paper, 18*s.*

(1) THE current theories of Alpine structure are based on two main explanations. According to one, Alpine mountains consist of bands of the crust which have been crumpled by contraction consequent on the diminishing size of the earth. According to the second explanation—the *Versluckung* or the swallowing theory of Schwinner—a band of the crust sinks into a lower zone, and there undergoes intense compression, accompanied by the metamorphism of its rocks.

Dr. F. Heritsch, of Graz, discusses these two hypotheses in a masterly survey of the principles of Alpine geology. He deals mainly with the Eastern Alps. The treatment is very technical and would be easier to follow if illustrated by a general sketch map. The first part of the book consists of a series of essays on the principles of rock folding; he therein discusses the nature of geosynclines, of local and widespread movements of the crust, and the formation of foredeeps. In his account of the widespread or epeirogenetic movements he lays stress on the oscillation which often accompanies variations in coast levels. He then discusses the phenomena of folding, overfolding

and overthrusting; he deals mainly with observed examples, as he regrets that tendency to consider folding from general principles which has often led to a geometrical rather than a geological treatment of the problems. He next deals with the behaviour of rocks under pressure and gives an excellent account of dynamometamorphism, mylonitisation, and the plasticity of rocks.

The largest part of the book consists of an account of the structure of the Alps in which the author insists on the "impossibility" of the overthrust theory in its present dominant form. He supports the "swallowing theory" which represents the crust of the earth as being under conditions analogous to those of the atmosphere. In certain areas, which correspond to the anticyclones, the movement of the material is upward, leading to the formation of volcanoes and the rupturing of the crust. In other areas, which correspond to cyclones, the crust moves downward, producing fold mountain chains owing to the lateral pressure, and also widespread metamorphism. Overthrusting inevitably takes place in the subsiding area, but the thrusts have a more limited horizontal extension than is claimed by the upholders of the *Deckentheorie*, which in its extreme form Dr. Heritsch describes as mere phantasy. The swallowing theory is, however, not inconsistent with the general contraction of the earth. It in fact renders that process more probable by rejecting the immense horizontal overthrusts which are too great for contraction alone to explain. The deformation of the earth by contraction indeed supplies the power which is required for regional uplifts and causes the subsidence of the intensely crumpled bands which have formed the fold mountain chains at different places at successive periods in the earth's history.

Dr. Heritsch's book is an able and sane statement on a complex branch of geology. It should be a useful corrective to the exaggerations of one school of Alpine geologists.

(2) North of the Alps lies the province of Württemberg, which has been affected by some of the Alpine movements but presents a marked contrast by its comparatively simple though varied geology. The province has played an important part in the history of geology. Tübingen has been one of the great geological schools of Germany, and, as Dr. Hennig reminds us, both Kilima Njaro and Kenya were discovered by men of Württemberg, though they were both at the time in the service of a British Missionary Society. The richness of Württemberg in fossils made it one of the chief centres of German palæontology, and the museums of Tübingen and Stuttgart are so rich in types that they have attracted generations of geological pilgrims. The province includes one of the most typical series of Jurassic rocks, an illuminating group of pygmy volcanoes and structures throwing light on the physical and glacial geography of the northern Alps.

The comprehensive summary of the geology of Württemberg prepared by Prof. Hennig, of Tübingen, is therefore welcome, as it gives an up-to-date summary of the German Jurassic system and a guide to the localities made famous by the work of Quenstedt. The first part has been issued, and it deals with the orography and with the stratigraphy up to the end of the Jurassic. The two sections of this part which will be of widest interest are the account of the Trias with its rich development of the Muschelkalk and of the Suabian Jurassics, which include the rich coral reefs for which the locality of Natheim has been especially famous.

The book is illustrated by two excellent coloured maps, one of the orography and one of the geology of Württemberg, by many clear diagrams of the palæogeography and lateral variations of the rocks, and a correlation of the English and German Jurassic deposits. In the author's classification of valleys, p. 7, he uses the term "isoclinal valley" for those in which the dip is the same on both banks owing to the valley having been cut in an inclined sheet of rock. This term is so likely to be confused with an isoclinal in which the equal dip on both sides of the axis is due to overfolding, that it is to be hoped that the new usage will not be generally adopted; for such valleys either the terms uniclinal or homoclinal are available.

(3) Forel's "Handbuch der Seenkunde," the standard text-book on the physical geography of lakes, was published in 1901, so that a new work was desirable, and the previous writings of Prof. Halbfass, of Jena, have shown, by his wide knowledge of the scattered literature on the subject, that he is especially competent for its preparation. His book is based on the principle that the essential feature of a lake is its water and not its basin. Hence a larger part of the volume is devoted to the physics and chemistry of lakes than to the nature of their basins. He discusses the movements of lake waters due to thermal changes, and to seiches, and variations of the shore lines caused by the tilting of the crust. There are short chapters on the optical and acoustical properties of lakes, including in the latter the "Barisal guns," which appear, however, to be due to seismic influences on delta deposits and to have no connexion with lakes. The mirage effects in some Hungarian lakes are illustrated graphically by a series of views taken at intervals during the day. There is an especially useful summary of the chemistry of lake waters. The chapter on the biology consists of only two pages; it considers the relations of some animals living in deep lakes and accepts them as

survivals from a cold-water fauna which had a widespread distribution at the end of the glacial period.

In dealing with the variations of lake levels, Prof. Halbfass discusses the asserted dessication of the continents. This view he dismisses most emphatically. The fall in level of many lakes he attributes to artificial influences, and he holds that lakes in all parts of the world show that there has been no general lowering of their level in historic times. He refers especially to Lake Chad, which he says is placed in the first line by the "dessication fanatics." He holds that this lake gives them no support since Marquardsen has shown that for eighty years after the visit of Denham (*i.e.* from 1824 to 1905), the boundary of the lake has remained essentially the same. In dealing with this problem he refers to Bruckner's thirty-five-year climatic cycle period, which he says is not confirmed by the evidence of the lakes of at least four of the continents; yet he holds that there is an actual climatic period, which is three times as long as the Bruckner period.

In the chapters on the distribution and origin of lake basins Prof. Halbfass rejects their glacial origin, except in so far as many of them occupy hollows in drift, or are held up by moraine dams. He rejects not only the glacial origin of deep rock basins but of many lakes of the Baltic Plain for which glacial denudation seemed far more probable. He adopts the views of Wahnschaffe and Jentzsch that these basins are due to tectonic subsidences, and in some cases, such as that of the Rogasener Lake in Posen, the basin, though now all covered with drift deposits, was pre-glacial in origin. In dealing with this problem Prof. Cotton's book (4), which is a general summary of physiography illustrated by examples from New Zealand, is less in accordance with recent opinion; for he represents the New Zealand fiords as glacially cut troughs of which the lower parts have been filled by the sea. They appear to agree with those of Norway, where the overwhelming balance of opinion is in favour of the pre-glacial age of the fiords. Prof. Cotton has an exceptionally fascinating subject, as New Zealand is especially rich in clear examples of geographical processes.

The book is well illustrated and his views are clearly stated. It illustrates the growing extent to which some schools in Australasia are dominated by American opinion; this fact, in the case of geography, is easily explained by the attraction of that logical scheme of geographical evolution for which we are deeply indebted to Prof. W. M. Davies. The extent to which British work is overlooked may be judged by the bibliography. Of the 59 memoirs quoted only five are British, and they date from 1802 to 1876, the latest contribution in this list by any British worker being Thomson's paper on the windings of rivers.

Our Bookshelf.

Theorie der Kristallstruktur: ein Lehrbuch. Von Prof. Dr. Artur Schoenflies. Pp. xii + 555. (Berlin: Gebrüder Borntraeger, 1923.) 18*s*.

APART from its obvious indispensability to the specialist, this new edition of the author's former "Krystallsysteme und Krystallstruktur" (1891) would seem to bear a character of wider significance, as showing that wisdom is justified of her children. There can be few such signal instances in science in which an abstract and apparently unverifiable theory has been so rapidly brought within the ambit of the experimental method, and proved to be equal to all demands. It is, therefore, peculiarly appropriate that one of the original founders of the modern theory of crystal structure should return to his subject in the light of recent X-ray developments. By including a discussion of those points in which the theory is still ahead of experiment, the author contrives to confer on his work a new prospective value.

The book is, of course, mainly concerned with a systematic development of the 32 classes of symmetry and the 230 possible ways in which matter may be properly disposed throughout the space occupied by a crystal. The general arrangement is necessarily much the same as before, but the exposition has been vastly improved in at least one particular. The former edition was solely addressed to the mathematician, to whom the addition of anything of the nature of a diagram (unless it take the special form of a symbol) would presumably impede the working of pure thought. The present work is rather directed to the crystallographer and X-ray analyst, and is therefore illustrated with structural diagrams, praiseworthy alike in quality and quantity.

In view of the existence of such an authoritative treatise as the Braggs' "X-rays and Crystal Structure," the author has refrained from entering into any account of the practice of X-ray investigation. It is, however, evident that the actual results are fully appreciated, for considerable space is devoted throughout the text to a systematic treatment of the relations between the number of particles (as also their symmetry) and the various positions they occupy in the structure. Moreover, a special chapter is devoted to space-partitioning and the packing of equal spheres; whilst another, possibly the most important of all, deals with selected cases investigated by X-ray workers. This inevitably leads to a discussion of the possible influence subatomic structure may exert on the physical manifestations of a crystal, and to a final conclusion that the only possible way of further progress is along the path of experiment.

It may be added, in conclusion, that those qualities of clear and concise expression, which have always made Dr. Schoenflies' writings the most favoured original source in the domain of crystal structure, are fully preserved. By bringing out so valuable a work in the face of obvious contemporary difficulties, both author and publishers have placed a wide-spread body of workers under a debt of gratitude, which they can scarcely ever discharge.

T. V. B.

The New Natural History: Being the Twenty-Fifth Robert Boyle Lecture delivered before the Junior Scientific Club of the University of Oxford on 6th June, 1923. By Prof. J. Arthur Thomson. Pp. 19. (London: Oxford University Press, 1923.) 1*s.* net.

In this refreshing and stimulating address Prof. J. Arthur Thomson pleads for the retention of the term natural history as a designation for the study of the habits and surroundings of animals and their inter-relations with one another—the new natural history—and for its more honourable recognition as a well-defined and integral department of biological science.

Out of the ashes of the old all-embracing science of natural history, the author traces the growth of the new science under the influence of various factors which have moulded its development. Chief among these is the recognition and appreciation of the great fact of the inter-relations of living organisms in the web of life and the external linkages between animals or animals and plants—the central Darwinian idea of the correlation of organisms. This has given direction and stimulus to the study of natural history and forms one of the guiding principles of the new science. No less important is the new and more precise scientific outlook on the question of animal behaviour, due to the work of Lord Avebury, Romanes, and especially Lloyd Morgan, who laid the firm foundations of an experimental comparative psychology, and to Loeb, who has done so much to develop the question on the physiological side. From the somewhat chaotic mixture of anthropomorphism and automatism there has emerged a precise science that distinguishes instinctive from intelligent behaviour and both from tropisms and forced movements.

A third factor which has given precision to the observations of the field naturalist and a new significance to his facts is the idea of evolution. With this as a working hypothesis the student of natural history has been stimulated to discover how a particular structure or function is fitted to a particular situation, and the study of adaptations has developed into an important and exact science.

The vision of the new natural history as a study of "animal personalities at various levels, as creatures with mental aspects, as agents that seek after well-being and share in their own further evolution, as threads in a quivering web of life" is indeed an inspiring one. Prof. Thomson justifies his plea, and the recognition which he asks for cannot be long withheld.

Alternating Current Electrical Engineering. By W. T. Maccall. Pp. viii + 493. (London: University Tutorial Press, Ltd., 1923.) 15*s.*

A fairly complete résumé of practical alternating current theory is given in this work. In order to keep the subject matter within the limits of one volume the explanations have to be made very concise. It is therefore more suitable as a class book than for reading by the private student. It covers a very wide field. The theory is now beginning to crystallise, and so numerical examples have been introduced which will enable the student to test the thoroughness of his knowledge.

The book is on the whole well written. The author sometimes gives results as if they obviously followed from the given premisses; for example, in describing how two induction motors are connected in cascade, he says that the supply mains are connected to the stator of one motor and its rotor is used to supply power to the second stator. "The result is that the synchronous speed of the combination is that of a motor whose number of poles is equal to the sum of the number of poles of the two motors." This is a hard saying, and we hope few readers will accept it without trying to make up some proof for themselves. If the author made the distinction between "average power" and "instantaneous power" clearer the proofs of the two and three wattmeter methods would be greatly improved. At the foot of page 61 a reference is made to the instantaneous value of the average power. A vector proof is given of the three-voltmeter method of measuring power, and it is stated that it should not be used unless the wave forms are nearly sine shaped. The ordinary algebraical proof shows at once that it is true, however distorted the wave forms may be. The Behrend definition of the leakage factor of an induction motor is given, and one of the methods described of determining its value is by Behn-Eschenburg's formula, which applies to a totally different definition of leakage factor.

Popular Fallacies Explained and Corrected (with Copious References to Authorities). By A. S. E. Ackermann. Third edition. Pp. xvi + 984. (London: The Old Westminster Press, 1923.) 12*s.* 6*d.* net.

To every one who has made a special study of any particular branch of human knowledge there must, at some time or another, have come a feeling of surprise at the large number of errors which exist in the popular mind regarding his own, and therefore presumably every other, subject. The previous editions of this book have proved of immense value in helping to correct the many errors which still persist in spite of the progress of popular education and the many devices now used for the dissemination of accurate information. A very real welcome is, therefore, assured for this, the third edition, which has been so extended in scope that it has become almost a new work. The number of fallacies dealt with has been increased from 460 to 1350, and these cover practically every branch of human activity. Indeed, so wide is the field covered, that a reviewer may be pardoned for paying particular attention to those sections by which he may expect to be best able to judge of the value of the whole. Engineering, general science, and astronomy receive their full share of attention at the author's hands—as might, indeed, be expected from one whose qualifications lie particularly in the first-named subject—and a close perusal of these sections has abundantly demonstrated the painstaking accuracy of the author's work. As Sir Richard Gregory points out in an appreciative introduction, a valuable feature of the book is the constructive work which it does in giving the truth of any matter concerning which an error is exposed. In conclusion it should be mentioned that the book is written in an eminently readable style, not unenlivened with touches of genuine humour. It is, moreover, well printed and may be cordially recommended as a useful addition to the library of general knowledge.

Heat and Energy. By D. R. Pye. (Clarendon Science Series.) Pp. xii+211. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 5s. net.

As stated in the preface, this book is not designed to be a text-book in the ordinary sense of the word. It is intended to be read by the advanced schoolboy to supplement the detailed instruction he has received in the class-room and the laboratory, with the view of imparting a broader conception of energy in its different forms. The first six chapters are devoted to heat, the chief phenomena being described and explained with less detail than is customary in the ordinary text-book. The relation between heat and work is then dealt with, followed by chapters on energy as light and sound. The remaining part of the book is taken up with practical applications of energy in the production of power, warming, ventilation, and refrigeration, the principles involved being clearly explained.

On these lines the author has produced a very readable volume, but it is difficult to see why he fails to give an account of electricity as a form of energy, as in these days almost every boy is interested in electricity through the medium of "wireless." A further addition, in the form of a few pages on the measurement of high temperatures, might be recommended, not only because of the practical importance of the subject, but also for the interest it creates in the mind of the young student of science. Apart from these omissions, however, there is no doubt that the careful reading of this book by an intelligent schoolboy would give him a much wider outlook than that provided by the ordinary text-book. C. R. D.

The Dance of Life. By Havelock Ellis. Pp. xiv+340. (London, Bombay and Sydney: Constable and Co., Ltd., 1923.) 12s. net.

THE main contention in "The Dance of Life" is that life is an art, as its expressions in morals and religion (which the author calls "mysticism"), in writing and thinking, and even in science, are arts, appropriately typified by the art of dancing. Life, in all its forms, is creative, the result of an impulsive outflowing. Accordingly, rigid laws, externally imposed, are really inapplicable to it. The dynamic is refractory to regulation by the static. What law there is must needs be from within; the formulation of the impulse of which it is the law. Mr. Havelock Ellis is not the only prophet of this doctrine in recent times; and, indeed, its underlying thought is a very old one indeed—a thought never quite forgotten even when the dynamic movements of reality were caught and crystallised in the static formulæ of philosophy and science. But it is none the less, when stated in isolation, a paradoxical view; and not least so when it is applied to a solution of the social problems of the present day. Yet "The Dance of Life" is a very stimulating and, indeed, challenging book, in itself a work of no mean art. Though in appearance roughly flung together, its several chapters have a single thread of thought—the view to which allusion has been made—running through them all. Philosophers of many schools and men of science alike may find much to disagree with in this book; but none can read it without interest, and few without some profit.

The Subject Index to Periodicals, 1920. Issued by the Library Association. F: *Education and Child Welfare.* Pp. 29. (London: Grafton and Co., 1923.) 4s. net.

THE Library Association maintains in this section of its Subject Index the high standard of quality of the earlier issues, but when one compares it with the American "Readers' Guide," the 1919–21 volume of which was published last year, one cannot but regret that the English Index is so deeply in arrear. It is true that it gleans over a much wider field, but it is questionable whether it would not be better to speed up the work even though this should necessitate some restriction of the sphere of operations. In this Education and Child Welfare section, professional and technical education, mental tests, the teaching of citizenship, languages (especially Latin), economics, geography, mathematics, and religious education all figure largely.

The articles indexed under science teaching are chiefly from the *School Science Review* and *Parents' Review*, but include some from the *Revue Pédagogique*, *Science Monthly*, and NATURE. The quarterly *Educational Record* published by the American Council on Education does not appear to be included within the scope of the work. It contained in 1920 important articles by President A. T. Hadley, Prof. G. D. Strayer, Dr. S. P. Capen, and other well-known authorities, which might with advantage have been mentioned in the Index.

Outlines of the Calculus for Science and Engineering Students. By Dr. Terry Thomas. Pp. 127. (London: Mills and Boon, Ltd., 1922.) 3s. 6d. net.

MANY students will find Dr. Terry Thomas's latest book of considerable value, not for private study of the subject, but also for use with oral lessons and for revision purposes. Although Dr. Thomas's brevity is a welcome change from the prolixity of some recent mathematical text-books, it is yet too pronounced a feature in the present volume, reducing the subject-matter almost to the tabloid form. The course is nevertheless a very suitable one and the examples are well chosen.

One or two criticisms of detail may perhaps be useful to the author if a second edition is called for. The "don't" of p. 10 is transgressed by the author himself on pp. 34, 75, etc. Students should be taught to distinguish between ordinary and partial differentiation as regards symbolism: it saves a good deal of trouble. The example chosen on p. 80 to show the "impossibility" of separating x and y is rather unfortunate. S. B.

Supplementary Notes on Gravimetric Analysis for Beginners. By W. Lowson. Pp. vi+58. (London: Longmans, Green and Co., 1923.) 2s. 6d.

THESE notes are intended to be used in conjunction with regular text-books. There are many valuable hints on practical details, and items of theory which are not easily found by students. The book will be found useful by those beginning quantitative analysis (the calibration of volumetric apparatus is included), and its moderate price will commend itself to students.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Polarisation of Double Bonds.

IN the September number of the *Philosophical Magazine* Sir Joseph Thomson has applied the theory of electrostatic induction to explain the mechanism of polarisation of double bonds and of the orientation of substituents in the benzene series.

Electrostatic induction is what we have imagined to be responsible for the "general" electrical effect of a substituent by producing a kind of drift of electrons in the molecule as shown in the scheme

$$Cl - + C_1 - + C_2 - + C_3 - + C_4 - + H$$

and we have attributed the superposed alternating polar effect to other causes, and predominantly to the laws of valency in their application to polarised complexes. In such a system as that depicted above, Sir Joseph Thomson suggests (p. 511) that as the result of the existence of the electrostatic doublet between Cl and C_1, electrons will crowd into C_1 from C_2, and into C_3 from C_4, and thus an alternating condition will be brought about in the chain. But for the same reason that electrons pass from C_2 into C_1, it would seem to us that electrons should also pass from C_3 into C_2, and the effect would then be continuous although diminishing in degree along the chain. The precise manner in which the difficulty is overcome is not quite clear, but we gather that Sir Joseph Thomson holds that electrons may pass from one carbon atom to another, if these are joined by a double bond, but not if they are joined by a single bond, which view would require the acceptance of the Kekulé benzene formula in its simplest form, and would be contrary to all the indications of modern researches on the conjugation of ethylenic groups and on intra-annular tautomerism.

A much more obvious, though not more serious, objection to Sir Joseph Thomson's method of deduction of the alternate effect is that while it leads to the right result in fifty per cent. of the cases, it leads to the wrong result in the remaining fifty per cent. For example, the direction of polarisation of the double bond in vinyl chloride, the example which Sir Joseph Thomson himself selects, is just the opposite of what experiment indicates. Thus, he provides the carbon atom which is attached to the chlorine with a greater density of electrons than the other, as indicated by the symbol $CH_2 \cdots CH \cdot Cl$, where the lower dotted line represents, say x electrons, and the other represents $2 - x$ electrons, the whole symbol thus indicating an augmented electronic density on that side of the double bond which is nearest the chlorine atom and a decreased density on the other carbon atom.

Now, it is easy to see that this process tends to produce a positive charge on the CH_2 carbon and a negative charge elsewhere, and consequently the carbon atom of the CH_2 group should, if anything, attract negative ions, and the product of the action of hydrogen chloride on vinyl chloride ought to be ethylene dichloride $CH_2Cl - CH_2Cl$. But, as Sir Joseph Thomson correctly states on p. 508, it is the carbon atom to which halogen is attached in a substituted ethylene which attracts negative ions. Were it proposed to escape this dilemma by assuming that the atom with the diminished density of electrons is the one which is ultimately found attached to the positive ion or radicle of the reactant, then further difficulties emerge and, for example, in the group $C_3 = C_2 - \overleftarrow{C_1} = O$, it would be necessary to postulate a passage of electrons in the direction indicated by the arrow in order to reconcile Sir Joseph Thomson's theory of the mechanism of induction with the experimental fact that invariably C_3 is the atom which is found attached to the negative radicle or ion of the reactant. Without going into detail it is obvious that similar considerations apply to orientation in the benzene series.

Finally, the classification of atoms as "chemically active" or "chemically inert," according as there is a defect or excess of electrons respectively, is unsatisfactory, since both types appear to be reactive under the correct conditions. Charged centres in polarised molecules are analogous to charged ions and it is difficult to see why the comparison should not be extended to their reactions.

A. LAPWORTH.
R. ROBINSON.

The University, Manchester.

River Pollution.

THE Salmon and Freshwater Fisheries Act, 1923, will come into operation on January 1 next, replacing the many Acts, beginning with that of 1861, which have been framed to regulate the fisheries of our inland waters. The first of the series contained a clause relating to the pollution of rivers, and this clause has up to now been practically the only statutory control we have had. It was reinforced by the River Pollution Prevention Acts, and this legislation was sufficient to prevent sewage being poured in an untreated state into rivers, but not into estuaries, and it proved ineffective in preventing poisonous effluents from industrial concerns contaminating both.

The new Act defines rather better the nature of the pollution which will be regarded as an offence (Section 8), empowers fishery boards to institute proceedings under the River Pollution Prevention Acts, 1876 to 1893 (Section 55), and provides (Section 73) for cases being tried before the nearest court of summary jurisdiction.

The rivers in the meantime have been allowed to get into a serious state of deterioration, due to the great developments of population and of industries. Our legislation hitherto has prevented any undue contamination by sewage of the non-estuarine parts of the rivers. It was really strong enough to prevent pollution by effluents from commercial works. But the dominance and importance of the industries have been usually overpowering, with the result that many of our rivers and streams have been allowed to get so severely polluted that they are almost, or altogether, devoid of life. The estuaries, with the growth of industries and of towns and cities, have been exposed to pollution from trade effluents to a greater extent than the river, and have had to carry a steadily growing burden of sewage. The result, as is well known, is that some estuaries are so badly polluted as to prevent the passage of migratory fish, and many others have got near the same state. With the advent of the new Act we have inherited an interesting and important problem, a problem which, like previous legislation, is a product of the industrial growth of the Victorian period.

Already some progress has been made by experiment and inquiry to state more distinctly the problem and the solution. The Ministry of Agriculture and Fisheries has shown its sympathy and its appreciation of the condition of the freshwater fisheries by appointing a Standing Committee on Rivers Pollution, and

by instituting Sub-Committees for some of the important watersheds. But it is difficult to understand the attitude of the Ministry of Health and of medical officers. At two recent inquiries relating to new sewers which were designed to discharge sewage untreated into an estuary, the representative of the Ministry of Health admitted that the estuary was already overcharged with sewage, but said that the new sewers would not alter that aspect of the question, that the estuary was so bad now that it would by this addition be very little the worse.

The medical officer goes further. He says the deaths of the fish in the estuary are caused entirely by trade effluents, and that we should get more powers to deal with such pollution. As for the sewage, he will tell you that no matter how great the quantity it is not unhealthy, it is not in any way related to the destruction of fish, and he will produce statistics to show that the healthiest parts of the county and the city are just where the sewage contamination is heaviest.

Without attempting at present to deny the truth of his extraordinary statements or presuming to explain the reason for his making them, it ought to be pointed out that, even if he is right, he is arguing that it is not necessary in any case to treat sewage, and therefore that authorities everywhere should be freed from the necessity and the expense of doing so. Indeed, we should not lose sight of the fact that if the killing of the fish in the river from whatever cause proceeds to the phase of practical extermination, an important and essential feature of the river will come to an end, nor of the probability that the authorities throughout the watershed will object to being subjected to an expense no longer necessary. The river in such a case would be converted into a sewer, a condition which is already met with in some of our estuaries and rivers. The river boards, on the other hand, are desirous to preserve the rivers as rivers, and to save them from becoming sewers.

The experiments which have been made with reference to the estuary of the Tyne have demonstrated plainly (1) that it is over-polluted with sewage; (2) that it is frequently little better in composition than the liquid outflowing from the sewers; (3) that the sewage in the region opposite Newcastle is the cause of a serious diminution in the quantity of dissolved oxygen; (4) that the oxygen frequently descends below the limit necessary to sustain fish life, and is only restored by freshets from the river; (5) that in consequence, during dry weather conditions, many deaths occur, either by direct poisoning or by the lack of oxygen. It has been proved by experiment, moreover, that the sewage alone will cause death, and that it may be directly poisonous to fish.

It is obvious, therefore, that in the case of the Tyne and of many other rivers of our country, both the river and the estuary will have to be cleaned. In the case of the river, trade effluents will have to be treated to prevent any poisonous effects. The estuary is far more important, for at present it is liable to provide an impassable barrier to fish. The solution of the problem is not an easy one, but it will have to be faced some time, and, we hope, before the barrier becomes so great that migratory fish will have ceased to enter the river.

Even with the powers conferred by the new Act, little will be accomplished unless with the sympathetic co-operation of the authorities and the owners of works. Already they have shown a strong disposition to help in the inquiries and in taking steps to minimise the effects of the effluents. As soon as it is clearly realised by all concerned that action is necessary, it will not be so difficult to indicate in what direction it should proceed.

A. Meek.

The "J" Phenomena and X-ray Scattering.

In a number of recent papers, Prof. A. H. Compton brings forward what purports to be a Quantum Theory of the scattering of X-rays. I venture to think that this theory—or more correctly system of rules—has little connexion with the phenomena of X-ray scattering as I observed it nearly twenty years ago, and as I still know it. I do not wish to write of the inconsistency or illogicality of the theoretical assumptions, for they are probably as well known to Prof. Compton as to the most careful reader. Prof. Compton seems to hope that, in spite of this, the truth will emerge. But I am compelled to state a few significant facts which are not common knowledge.

Regarding the experimental observations establishing a difference between the primary and the secondary radiations *observed* (assumed by him to be scattered radiations), I should like to point out that they date from the earliest experiments on the subject (see Sagnac; Barkla, *Phil. Mag.*, 1904; Beatty; before those to which he refers). It is very easy to detect differences in the penetrating powers between the primary and secondary (scattered) X-radiations as ordinarily measured.

The greatest difficulty has been experienced by experimenters, not in establishing a difference between the primary and secondary radiations, but in showing that they are at all similar. They have not always realised the conditions essential for this. The necessity of using soft X-radiations in order to obtain evidence of the purest scattering and the almost perfect agreement with the classical Thomson theory, I have emphasised again and again. There have been various reasons for this, some obvious, others long since observed but only recently studied. The superposed radiation excited in the scattering substance by the swift electrons constituting the secondary corpuscular radiation and the possible emission of further unknown fluorescent X-radiations are among the obvious. For many years now I have known of a further and more important source of error; this is connected with what I have called the "J" radiations, discontinuities, or transformations. The important fact, whatever its explanation, is that a beam of X-rays in transmission through matter under certain critical conditions becomes considerably more absorbable both in that and other substances. We have made scores of experiments of various kinds on this abrupt transformation; more will be said of it elsewhere. What concerns us at present is that this is of such a magnitude as would be accounted for by an absorption and re-emission of the radiation with an increased wave-length of the magnitude required by Compton—about 0·02 Å.U. But this is in the direction of propagation of the primary beam; and experiments do not seem to support this view as to the nature of the change. Absorption in this region evidently depends upon factors other than wave-length and atomic number. This is the J discontinuity which I mentioned in 1916 (Bakerian lecture) and again with Miss White in 1917 (*Phil. Mag.*, Oct. 1917).

We can now certainly say that these J transformations not only *might* produce, but actually *do* produce the softening which *we* have observed in the scattered radiation in many experiments at any rate. It is not unreasonable to suppose that it is the explanation of the changes observed by others, not only in the region of wave-lengths over which we can make a definite test, but also over the range of shorter wave-lengths, over which we are not at present able to get control.

It is impossible in the space now at my disposal to give full evidence for this; but the only rational conclusion is, that this transformation observed is not in the process of scattering but in the subsequent

transmission of the scattered radiation through the radiating substance and through the absorbers.

Prof. Compton apparently did not read between the lines of a communication to the *Philosophical Magazine* (Barkla and Mrs. Sale, April 1923); but as the results do not suit his formula he makes a suggestion of how such results might have been obtained by very incompetent experimenters. May I now suggest to Prof. Compton that, in addition to taking other very obvious precautions, he might also use soft radiations, very thin radiators, and very thin absorbers. I do not think he will then have much difficulty in obtaining scattered radiation very like the primary and very different from what would be given by his formula.

Regarding the transformations of radiations of shorter wave-length, I will only say that it is much more difficult to obtain anything like equality of penetrating power between primary and scattered as usually detected; but an explanation of this can be given,—not the ultimate explanation, but again in terms of the J transformations.

Further, let us examine the theory of the recoiling electrons. Giving the Compton formula the best chance of success, consider what would happen to the electrons in hydrogen which require little energy for their extraction. These electrons scatter as much as a similar number in other substances (Barkla and Crowther). A simple calculation shows that when the K radiation of tin is employed, the recoil electron should produce an ionisation of the order of 1/100th part of that produced in air by the same X-radiations through the ordinary long-range electrons. Now Shearer in this laboratory observed in hydrogen an ionisation as low as 0·0016 of the ionisation in air; and remarked on the strong probability of this being an over-estimate. This would be of the right order of magnitude for the effect of long-range electrons alone. Where then is the effect of ionisation by Compton's scattering electrons? It apparently does not exist.

The evidence Compton used and obtained from the study of γ-rays is necessarily much less trustworthy; the experimenters have probably never—indeed cannot have—realised the many possibilities of error. Any transformation to a softer type—or at any rate something equivalent to that—would entirely vitiate the results obtained both in absorption and scattering experiments. Without wishing to detract from the merit of the work, one may justifiably point out the difficulties of exact measurement in this region. One is led to ask: Are experiments on the diminution of scattering really trustworthy? Accurate they cannot be; they may be entirely misleading. Thus in cases we have investigated, Compton's formula holds neither for the apparent change of wave-length, nor for the energy of the recoil electrons. But we can quite easily get many of the effects of the kind Compton considers.

It is possible that the J transformation which we have observed will be explained by a theory bearing some resemblance to that of Compton for so-called scattering. This would be supported by the evidence of C. T. R. Wilson's "fish-tracks." It seems unfortunate that Prof. Compton should have applied the term scattering to a hypothetical process which is so essentially different from the scattering of X-rays as ordinarily known. The important conclusion is this—the results of experiments on scattering and the Thomson theory explaining these are absolutely untouched.

Many of the experiments upon which these conclusions have been based were obtained in collaboration with Mr. Khastgir and Mr. Stevens, in addition to those already mentioned. C. G. BARKLA.

University of Edinburgh.
November 10, 1923.

Scientific Names of Greek Derivation.

I AM glad that Sir Clifford Allbutt, in NATURE for October 20, p. 590, supports the spelling "deinosaur," although Owen wrote Dinosauria. Only a week ago I heard a university student pronounce the word as "dinnosaur." Wherever pronunciation can be helped by correcting current forms the correction is obviously of service. From this point of view we may pardon, even if we regret, Miocene and Pliocene. No one, however, has attempted to write "Plistocene." We have for some centuries converted the Latin forms *ae* and *oe* (for the Greek *αι* and *οι*) into the forms *æ* and *œ* in manuscript and in print; but this has no classical authority and can be abandoned with much advantage, as has been done in modern Latin texts. The Greek diphthong or semi-diphthong *ει* could not well be shortened into one letter in our script, and this fact provides an inconsistency for those who join *a* and *o* to *e* in transliterations from Greek or Latin. Where the word has become anglicised in form, as cœnosarc, or where, like cœnenchyma, it is not a generic or specific name, the diphthong no doubt will remain compounded; but we may, I think with wisdom, write Coeloptychium and Taenia. Moeritherium is a case that needs attention. The British Museum, which has an honourable vested interest in the mortal remains of this fascinating creature, writes the *o* and the *e* separately. The Americans, and now the Japanese, adopt the compounded form.

Dr. L. C. Purser, to whom I confide all my classical troubles, tells me that Herodotus (Book II., 148) gives the lake in the Fayūm as ἡ λίμνη ἡ Μοίριος, named from a king who would appear in Latin as Moeris. C. Stephanus ("Dictionarium historicum," A.D. 1633) prints "Mœridis stagnum"; but here again the separation of the *o* and *e* would seem advisable. I confess that I always write Cainozoic in preference to Caenozoic or Cænozoic, though the *æ* conforms best with our general usage. This term, however, never had a Latin form, and may now be regarded as an English word.

As I remarked in my note in NATURE for July 7 (p. 10), it is now difficult to be logical. The Encyclopædia Britannica gives us an article on Deinotherium, but makes us look under *di* for deinosaurs. Following Sir Clifford Allbutt, let us help pronouncers —and printers—where we can.

GRENVILLE A. J. COLE.

Carrickmines, Co. Dublin, October 28.

Is the Pentose of the Nucleotides formed under the Action of Insulin?

IN a letter to NATURE for June 16, p. 810, Messrs. Winter and Smith directed attention to their observation that the blood and certain other tissues of the rabbit contain, after injection of insulin, a substance which reacts as a carbohydrate towards the α-naphthol test, but has no reducing action on copper salts even after acid hydrolysis. Commenting on this they say: "It seems possible that the carbohydrate content of the animal body may be not appreciably diminished after large doses of insulin. The above facts would suggest that the sugar stored in the body as glycogen is converted into this peculiar form."

If I understand the suggestion correctly, it is that this unidentified carbohydrate substance is formed from glucose under the influence of insulin. If this is so, it should be present in normal blood and other tissues, but absent from those of diabetics.

Jackson has recently shown (*J. Biol. Chem.*, 1923, lvii. 121) that adenine nucleotide occurs in normal human blood. I have myself recorded its occurrence, together with other nucleotides, in the pancreas of

the dogfish (*J. Biol. Chem.*, 1921, xlv. 263), and pentose compounds, which have in many cases been identified as nucleotides, and are probably always present as such, have been found distributed through a wide range of animal tissues.

Is it possible that the carbohydrate substance referred to by Messrs. Winter and Smith is of a nucleotide nature? The nucleotides give the α-naphthol test, but there is a possibility of the pentose constituent, to which the reaction is due, escaping notice on testing a solution after acid hydrolysis for reducing power, especially if only a small quantity of material is available, moderately strong acid is used, and the hydrolysis is carried out in an open vessel at the boiling-point, since, in these circumstances, the pentose readily goes over to furfurol and is lost by volatilisation.

I hazard the suggestion for this reason. I have recently found that the tissue of the islet gland in a typical teleost fish (*Ophiodon elongatus*, Girard) is the richest in pentose compounds (nucleotides) of all the tissues of the body, notably richer than the zymogenous pancreatic tissue. Since it has been shown that the islet gland in such fishes is homologous with the isles of Langerhans in the mammalian pancreas, I have suggested, in a paper on the subject which is shortly to appear in the *Journal of Biological Chemistry*, that it would be justifiable to infer from this that the general high pentose content of the pancreas in mammals is due mainly to the presence of the isles of Langerhans.

With the view of tracing a connexion between the high pentose content of the islet tissue and its function of insulin production, I have made use of the hypothesis, put forward by Heilbron and Hollins (Rep. Brit. Ass., 1922, 396) to explain the formation of compounds of the C_5 series from those of the C_6 series in plants, that hydroxymethyl-furfuraldehyde is first formed by loss of water, and this goes over to a member of the C_5 series by respiratory oxidation. This transformation would seem to necessitate the pre-formation of an activated form of glucose, and I have suggested that the plant hormone, glucokinin, described by Collip (*J. Biol. Chem.*, 1923, lvi. 513) probably performs the function of activation.

If this is so, and pentose is formed in the animal organism from activated glucose by a similar series of steps as is postulated for plants, it seems to indicate a connexion between the production of insulin and the high concentration of pentose compounds in the islet tissue.

If there is anything in this idea it may also be applied to explain the production of pentose compounds in the blood and other tissues under the action of insulin, and it would be interesting in this connexion to determine whether adenine nucleotide occurs in the blood of diabetics.

C. BERKELEY.

Marine Biological Station,
Nanaimo, British Columbia,
October 15.

An Uncommon Type of Cloud.

THERE are many striking cloud phenomena which may be regarded as local. While the same general laws of cloud formation prevail in all climates, yet some forms, while not radically different, display varying degrees of magnitude or intensity in certain parts of the world.

The form known as "mammato-cumulus" or "festoon-cloud" or, as called in the Orkneys, "pocky cloud," is of this nature, and while it occurs in a very pronounced fashion in Australia, the United States, and other countries, it is almost a very rare phenomenon in the British Isles, and then, as a rule, in a very "mild" form.

An illustration which is usually given to represent this type is that which appears in the "International Cloud Atlas." It is from a negative by H. C. Russell, who secured it in Sydney, Australia, in the year 1893. It shows the type in its most intense form.

Less pronounced is the illustration given by M. J. Loisel in his "Atlas photographique des nuages," from a negative he took at Chiavari in Italy in 1908.

Still less pronounced is that given in the "Meteorological Glossary," issued by the Meteorological Office, from a negative by Capt. Cave taken in England in 1915.

It may be remarked that, while almost all books on meteorology refer somewhat in detail to this type of cloud, it is very rare that any illustration from a photograph accompanies the text. The reason for this is evidently due to the fact that this type does not occur very often in the British Isles, and when it does the phenomenon is a fleeting one, lasting for only a few minutes. Having observed and photographed clouds for many years, I have only seen this type on about six different occasions and photographed it on three; even then the type was not of a very pronounced nature.

FIG. 1.

In his book entitled "Cloud Studies," the late Mr. Arthur Clayden writes: "In some countries it seems to be frequently observed, but in England it is so uncommon that the writer has only noticed it about a dozen times in twenty years, and on no one of these did it last long enough to allow of its portrait being taken."

The main feature of this type of cloud is that it occurs on the underneath surface of a large cumulus cloud, and its appearance, in its most pronounced state, is of a globular formation exhibiting a large number of well-defined rounded masses of cloud hanging downwards below the main cloud. The cloud is generally associated with very disturbed atmospheric conditions, heavy rain, and with thunderstorms.

On October 22 last, at 12.45 P.M. G.M.T., an example of this form of cloud, very pronounced for this country, made its appearance at Sidmouth, South Devon, and lasted for only five minutes. I managed to secure two satisfactory photographs of it, one of which is here reproduced (Fig. 1). It shows clearly

the spherical formations hanging downwards with clear cut edges. If the photograph be turned upside down the appearance is that of the tops of cumulus clouds as seen from an aeroplane above them.

Just as the billowy tops of cumulus clouds are due to the *ascent* of warm moist air into cooler air above, so the globular formation of the festoon-cloud must be caused by the *descent* of warm moist air into an underlying cooler stratum. This inversion of temperature is generally indicative of bad weather, and this was corroborated by the weather experienced at and after the time the photograph was taken.

WILLIAM J. S. LOCKYER.

Norman Lockyer Observatory,
Sidmouth, South Devon.

The Tides.

THE great importance of the subject is my excuse for troubling you once more, very briefly, regarding it. In NATURE of July 21, I stated that, according to the present tidal theory, the tidal forces, and consequently the tides, would be just the same for a sea-depth of about 4000 miles as for the actual sea-depth of about 2 miles; and, in the same issue, your reviewer, "The Writer of the Note," agrees that this is true, or, in his own words, "that the differential motion of the oceans is determined by the vectorial excess of the forces at the earth's surface over those at its centre"; which appears to ignore entirely the depth of the ocean as a factor determining the height of the tides.

The theoretical cause of the tides is the difference of the attractions of thesun and moon at the earth's surface and centre. This difference in the case of the moon is more than twice as great as in the case of the sun; therefore, the lunar tide is more than twice as great as the solar tide. Similarly, if the earth were expanded into a hollow, spherical crust of ten times its present diameter, with its water-covered surface nearest to the moon at the same distance as now, and the moon's period of revolution also remaining the same, then the lunar tide-raising force, and consequently the tide, would be about twelve times as great as now. This is the teaching of the present tidal theory; but is it the teaching of practical mechanics and common sense? Why should the mere expansion of the earth cause a ten, or twenty, or a hundred times greater tide upon its surface, the distance of that surface from the moon, as well as the masses of the earth and moon, remaining the same as before the expansion?

Surely this is a question well worthy of discussion; and surely some of your readers are sufficiently interested and open-minded to express some opinion or argument regarding it.

EVAN MCLENNAN.

Corvallis, Oregon, U.S.A., September 3.

MR. MCLENNAN'S words "and consequently the tides" are not in accordance with dynamics and are not implied in the passage he quotes from my previous note. If the earth were all water the direct tide-generating forces within two miles of its surface would be the same as in an ocean of depth only two miles. These tidal forces are usually represented by reference to the "equilibrium tide," that is, by stating what the outer surface of the oceans would be if the water had lost its inertia without losing its gravitational properties. This outer surface would be the same in the two cases mentioned. The necessary continual adjustment of water, however, would be quite different in the two cases; in the first case the water within two miles of the surface would be largely raised and lowered by that beneath, while in the second case the water would move mainly in a horizontal direction. But owing to the actual inertia of the water the outer surface of the ocean would be entirely different in the two cases, so that the accepted theory does not ignore the depth of the ocean as a factor determining the height of the tides.

The expansion of the solid earth, with an increase in water sufficient to conserve the depth of the oceans would magnify the tides because the excess of the forces at the earth's surface over those at its centre would expand with the earth's radius. Mr. McLennan apparently finds this result of the gravitational theory repugnant to his common sense.

THE WRITER OF THE PREVIOUS NOTES.

Stirling's Theorem.

IN connexion with the recent letters published in NATURE on Stirling's Theorem, I beg to say that in a paper accepted for publication by the Academy of Zagreb on July 13, and now in print, I proved in quite an elementary manner the formula

$$n! = \sqrt{2\pi}\,.\,(n+a)^{n+\frac{1}{2}}\,.\,e^{-(n+a)},$$
$$a = 0\cdot2113249 \text{ or } 0\cdot7886751,$$

which coincides with the results published by Mr. James Henderson in NATURE of July 21, p. 97, formula (3). The error was found to be of the order of $1/72\sqrt{3}n^2$ of the calculated value, where $1/72\sqrt{3}$ is equal to $0\cdot00801875$ in Mr. Henderson's results. The formula may also be written

$$n! = p\left(\frac{n+a}{e}\right)^{n+\frac{1}{2}}$$

and the log p determined once for all. (For $a = 0\cdot2113249$, we have log $p = 0\cdot5244599$.) The work of calculation is then by no means greater than in using Stirling's or Mr. H. E. Soper's formula though the approximation is far closer. I think the doubt inferred by Mr. G. J. Lidstone in NATURE of August 25, p. 283, on the usefulness of the formulæ under discussion is not valid so far as the present one is concerned. For sufficiently large values of n, depending on the number of decimals of the tables, the result calculated from the above formula is not worse than that furnished by any other more complicated formula.

STANKO HONDL.

Zagreb, Croatia, SHS-State,
October 7.

PROF. HONDL'S simplified form of my best first approximation to the value of $n!$ follows at once from the fact that $(b-c) = \frac{1}{2}$ in my letter in NATURE of July 21. [b is Prof. Hondl's a.] The constant p in $n! = p\left(\frac{n+a}{e}\right)^{n+\frac{1}{2}}$ is $\sqrt{2\pi e^{(\frac{1}{2}-a)}}$.

We have now three approximations involving this type of expression where the index of the power is $(n+\frac{1}{2})$:

(1) $$\sqrt{2\pi}\left(\frac{n+\frac{1}{2}}{e}\right)^{n+\frac{1}{2}} \text{[Soper]},$$

(2) $$p\left(\frac{n+a}{e}\right)^{n+\frac{1}{2}},$$

(3) $$\sqrt{2\pi}\left\{\frac{\sqrt{n^2+n+\frac{1}{6}}}{e}\right\}^{n+\frac{1}{2}} \text{[Forsyth]}.$$

It is interesting to note the increase in accuracy as we proceed from (1) to (3). The errors are $1/24n$, $1/125n^2$, and $1/240n^3$ respectively. Of approximations of this type Forsyth's is by far the most accurate, but for logarithmic calculation it is rather more laborious.

JAMES HENDERSON.

Biometric Laboratory,
University College, London.

Thunderstorms and Globular Lightning.

By Dr. G. C. Simpson, F.R.S.

THERE is no real boundary between pure science and applied science, and it is inconceivable that any one whose life's work is the practical application of electricity should not be interested in all things electrical. One might, therefore, expect an electrical engineer to show at least a dilettante interest in atmospheric electricity, but one is surprised—although equally gratified—to find that the president of the Institution of Electrical Engineers devoted a large part of his inaugural address on October 18 to the discussion of the electrical potential gradient in the atmosphere and the mechanism of thunderstorms. There has been a great deal of work done on these subjects in recent years, but it cannot be said that the results have yet reached far beyond the small band of workers who are actually engaged in making the investigations. Dr. Alexander Russell has, therefore, done a good service to his fellow engineers in summarising for their benefit our present knowledge and indicating problems still unsolved.

Dr. Russell accepts the breaking drop theory for the origin of electricity in thunderstorms, but he appears unable to give up entirely the old idea that free electrons form nuclei for condensation in the atmosphere. There are certain ideas which once they have appeared in scientific literature cannot be eradicated no matter how conclusively they are shown to be wrong. C. T. R. Wilson in his classical work on the condensation of water on to ions showed two things: first, with great supersaturation water will condense, in the absence of other nuclei, on positive and negative ions; and secondly, that no condensation takes place on even the negative ions until fourfold supersaturation has been reached. This latter point is nearly always forgotten, and until some one has shown that fourfold supersaturation does exist in the atmosphere, meteorologists cannot recognise that ions play any rôle in the processes of atmospheric precipitation.

The breaking drop theory of thunderstorms has met with very wide acceptance; for it gives such a simple and complete account of the origin of the electricity and explains so many of the observed facts, such as the part played by ascending air currents, why the lightning flashes are mainly between the base and the top of the cloud, and why the rain carries sometimes a positive and sometimes a negative charge with the former preponderating.

The physical basis of the theory has been examined in great detail by Lenard in Germany and McClelland and Nolan in Dublin, and there can now be no doubt that the breaking of drops does produce a separation of electricity. There was, therefore, every justification for Dr. Russell to give the breaking of drops as the chief source of electricity in thunderstorms, but this is only a part of the complete theory of thunderstorms, which takes into account the part played by hail and explains also those winter thunderstorms in which there appears to be no drop formation.

The breaking drop theory was put forward as the result of work during the monsoon in India, and in the original paper it was said that there had been no opportunity to examine the electrical phenomena connected with ordinary rain or with snowstorms. That opportunity has since occurred, and has given the data for rounding off the theory so that it can now be applied to all kinds of atmospheric precipitation.

The separation of electricity on the violent disruption of a body is not confined to liquids, but occurs, probably more strongly, when solids are rapidly separated. Rudge's work on the electrification of dust clouds threw much light on this subject. When dust is blown up into the air, the dust particles are found to be highly charged. This is not an effect of frictional electricity as usually understood, because two different substances do not come into contact; for example, highly charged particles are obtained when sand consisting of pure silica is used to make a dust cloud. The effect appears to be exactly the same as in the case of the breaking drops; a violent separation of parts takes place, the substance obtains one kind of electricity while the other kind passes into the air probably in the form of large ions.

Rudge's work was undertaken to explain the high potential gradient observed in tropical regions during dust storms, but similar electrical effects are observed during blizzards in polar climates. There is physically no difference between a dust storm and a blizzard accompanied by much driven snow, and in both cases the particles of solid matter become charged in consequence of their frequent collisions. This is then the origin of electricity in snowstorms. One difficulty, however, must be faced. If the electrification takes place by collision, how does a sufficient separation of electricity take place to give a lightning flash, for this can only occur after some process has widely separated the electricity set free by the collisions? The answer is that so long as the cloud contains only snow which settles very slowly through the air, there is no thunderstorm; it is only when soft hail accompanies a snowstorm that thunder and lightning occur. As the soft hail falls through the snow flakes, electrification takes place on each collision and the falling hail carries away with it large charges of electricity. Thus the fall of the hail effects the separation of electricity which gives rise to the large electrical fields necessary for a thunderstorm. Compared with the electrical effects of a tropical thunderstorm with its heavy rainfall, the electrical effects of a snowstorm are almost insignificant, and during the polar winter, when there is no soft hail associated with the snowfall, thunder and lightning do not accompany the most violent snowstorms.

Dr. Russell in his address also gave considerable time to discussing globular or ball lightning. He came to the conclusion, which is now very generally held, that this is a real natural phenomenon with an objective existence. The chief characteristic of ball lightning may be summed up as follows:

(1) The body or ball itself, which is able to retain its individuality as it moves through the air, appears to be composed of gas or matter in some novel luminous condition.

(2) The balls appear to exist independently of any large electrical intensity, for they have been observed within closed rooms where large electrical fields are impossible, and have also

been observed to pass in and out of parallel telegraph wires.

(3) They appear to be associated directly or indirectly with large quantities of energy, for they have been observed to explode with violence, and have also been seen to fuse the overhead wire of an electrical tramway.

No satisfactory explanation of ball lightning has been offered. Dr. Russell says: "Globular lightning seems to be a brush discharge taking place at the end of a column of air of higher conductivity than the neighbouring air." He then points out some of the difficulties of this explanation, to which others can be added; in fact, there is really nothing very similar between a brush discharge and the ball of glowing gas so frequently described. The only physical phenomena yet produced in a laboratory at all approaching ball lightning is the active nitrogen studied by Lord Rayleigh. In this case we have a mass of nitrogen subjected to an electrical discharge which continues to glow for some time after it has been removed from the field. Lord Rayleigh, however, is unable to accept this explanation of ball lightning, and all that we are able to say is that active nitrogen is the nearest physical phenomenon to ball lightning yet produced in our laboratories. Ball lightning appears always to be associated with a thunderstorm, and it is possible that the intense discharge of a lightning flash can produce some atomic change in the air or rain through which the discharge passes. If this is so, the glowing matter of ball lightning may be in a state otherwise not met with in Nature.

Unusual Forms of Crystallisation of Cementite in Steel.

CEMENTITE, the carbide of iron, which confers on iron the properties of steel, exists in three principal forms in hypereutectoid steels, (1) the pseudo-dendritic form, (2) the cellular or intergranular form, and (3) the intragranular form which gives rise to the Widmannstätten structure. Pseudo-dendritic distribution arises directly from the irregular concentration of the solid solution which results on solidification. The cellular variety occurs between the grains, *i.e.* in the network of the grain junctions, while the Widmannstätten structure is caused by the precipitation of cementite in the interior of the grains themselves and shows evidence of the directive influence of the crystalline network of each grain.

A. M. Portevin has examined a sample of steel which has enabled him to make certain new observations in regard to these forms of cementite. These results were presented at the autumn meeting of the Iron and Steel Institute held recently in Italy. The sample was found in the hearth of a blast-furnace, and its exterior presented the characteristic concave facets peculiar to intergranular fracture. The grains of which it was composed were exceedingly well developed, their size being of the order of 1 cm. in transverse thickness and several centimetres in length. The specimen contained 1·22 per cent. of carbon, 1·35 of silicon, and 0·17 of phosphorus. It was, therefore, very distinctly hypereutectoid and corresponds, so far as carbon percentage is concerned, to a fairly hard cutting tool. An examination of the microstructure of this sample revealed the presence of the cellular and Widmannstätten modes of distribution of cementite, but the pseudo-dendritic form was absent.

INTRAGRANULAR CEMENTITE.

A micrographic section usually shows the cementite in needles arranged along three or four directions in each grain. This corresponds spacially with lamellæ parallel with the faces of the octahedron, and has the appearance which cementite assumes more particularly in case-hardened samples very high in carbon. In the sample examined by Portevin a different orientation of the intragranular cementite was observed. The constituent was present, not in the usual isolated rectilinear needles, but in the form of bundles of numerous very small needles, or of groups of elements crowded together. These were apparently elongated prisms analogous to the prismoids of Belaiew, grouped in masses. This is apparently the first time that intragranular cementite has been noticed with these morphological characteristics. It can, however, also be produced in steel which has been strongly case-hardened at a very high temperature and very slowly cooled. Inclusions and notably bubbles constituted centres of crystallisation around which the bundles of needles were grouped.

INTERGRANULAR CEMENTITE.

This is customarily described and represented as enveloping the grains and appearing in a section as continuous ribbon-like filaments which do not display any characteristic shape or orientation. Howe and Levy, however, have directed attention to the needle points which impinge from the cementite network into the interior of the grains, and have raised the question as to whether these take their direction in obedience to the crystallisation orientation of the adjacent grain or of that of the network itself. They have suggested that both influences manifest themselves, and that sometimes one and sometimes the other predominates. In the present sample there is no continuous network of cementite surrounding the grains. There is a grouping of this constituent along the confines of the grain joints, the variable orientation of which can sometimes be attributed to that of the intragranular elements of cementite dispersed within each grain and sometimes appears distinctly different. In other words, the two influences remarked by Howe and Levy manifest themselves. Fig. 1 represents the appearance obtained after oil-quenching at 950° C. followed by annealing at 550° C., a treatment which causes the great bulk of the pro-eutectoid cementite, and more especially the Widmannstäten cementite, to disappear. The photograph has been taken at the junction of three grains. The needles which compose the network have in one instance different directions in regard to each grain, giving the junction the appearance of the barbs of a feather, while in the two other junctions they have an almost uniform orientation. It appears that the structural elements of the network have distributed themselves along a mean direction or have assumed a direction of their own, the influences of the orientation of each grain conflicting with each other in the neighbourhood of the junction. The needles are

very short and it is difficult to ascertain their orientation with exactitude. The disturbance occasioned in the distribution of the structural elements which separate the grain junctions by the simultaneous influence of the varying orientations of each grain is thus manifest. Portevin remarks that some observers will not fail to interpret them as arising from the intervention of "amorphous material," whereas they can easily be interpreted as the resultant of two forces acting in different directions. He has observed a similar instance in the case of aluminium bronze containing 90 per cent. of copper which has been hardened and annealed. Here the intergranular elements of α separated along the grain joints have a different orientation from that of the acicular intragranular element.

FIG. 1.—Peculiar segregation of cementite at crystal boundaries. × 50.

Cementite, as is well known, is exceedingly sensitive to coalescence phenomena. The author has stimulated the coalescence of the pro-eutectoid cementite of the sample by heating it for 1·5 hours at 950° C. followed by oil-quenching, and then by one hour's annealing at 600° C. This gives darkly-etching sorbite in which the undissolved cementite appears white and is very clearly distinguishable. Under these conditions the coalescence of the cementite prismoids is shown by a rounding of the boundaries and the splitting up of the elements constituting the bundles, but in addition an agglomeration is observed which gives the cementite a pitted appearance and is misleadingly like the eutectic of white pig-iron. (See Fig. 2.) This pseudo-eutectic appearance, due to coalescence, appears to be a new observation and shows the intensity of the influence of surface tension on cementite at the above temperatures. The tension is, in this instance, an important morphological factor.

Another unusual type of occurrence of cementite in steel was described at the same meeting by Prof. Edwards and Mr. Pfeil. In this case, however, the phenomenon was observed in mild steel sheets, *i.e.* in hypo-eutectoid steels. Defects are sometimes encountered in such sheets when subjected to moderately deep stamping operations and consist of a series of corrugations in the side walls of the dish. The degree of corrugation increases on passing from the bottom to the top, and is, in all probability, due to the greater amount of cold work put upon the metal there. It was found that the microstructure of the steel consisted of two approximately equal parts: (*a*) a very coarsely crystalline layer apparently free from carbon, and (*b*) a finely crystalline layer in which no pearlite was present but the carbide was segregated at the crystal junctions in irregular nodules. A section cut from the corrugated part of the dish showed very coarse severely deformed crystals. Running round the crystal boundaries, however, was an almost continuous network of what may be termed "beaded" cementite. This constituent must have segregated from pearlite and coalesced into this form under the influence of surface tension during the annealing. Its appearance is shown in Fig. 3 at a magnification of 250 diameters. So far as the writer is aware, this type of occurrence of cementite in a mild steel has not been previously described. The authors have not proposed any explanation of how it is brought about, but are endeavouring to produce it intentionally. Clearly much work still remains to be done to explain the various forms of cementite which may and do occur in both hypo- and hyper-eutectoid steels.

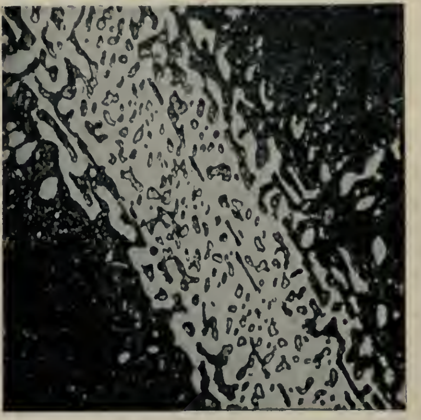

FIG. 2.—Eutectic-like appearance of cementite. × 500.

FIG. 3.—Beaded cementite at crystal boundaries of ferrite. × 250.

H. C. H. C.

Some Developments of Modern Zoology.[1]

By Prof. J. H. ASHWORTH, D.Sc., F.R.S.

ZOOLOGY has far outgrown its early boundaries when it could be defined simply as a part of natural history, and at no period has its growth been more rapid or more productive in results of scientific and practical importance than during the last two or three decades. That period has witnessed a growth of our knowledge of the living organism of the same order of importance as the progress in our knowledge of the atom. Never have investigators probed so deeply or with so much insight into the fundamental problems of the living animal; the means for observation and recording have become more delicate, and technique of all kinds more perfect, so that we can perceive details of structure and follow manifestations of activity of the organism which escaped our predecessors.

Among the notable features of zoological activity during the last twenty-five years, the amount of work on the physiology of organisms other than mammals must attract early notice in any general survey of the period. Eighty years ago Johannes Müller's physiological work was largely from the comparative point of view, but for some years after his death the comparative method fell into disuse, and the science of physiology was concerned chiefly with the mode of action of the organs of man or of animals closely related to man, the results of which have been of outstanding importance from their bearing on medicine. Interest in the more general applications of physiology was revived by Claude Bernard ("Leçons sur les phénomènes de la vie," 1878), and the appearance of Max Verworn's "General Physiology," in 1894, was in no inconsiderable measure responsible for the rapid extension of physiological methods of inquiry to the lower organisms—a development which has led to advances of fundamental importance. Many marine and freshwater organisms lend themselves more readily than the higher vertebrates to experimentation on the effects of alterations in the surrounding medium, on changes in metabolic activity, on the problems of fertilisation and early development, on the chemistry of growth and decline, and to the direct observation of the functioning of the individual organs and of the effects thereon of different kinds of stimuli. The study of these phenomena has greatly modified our interpretation of the responses of animals and has given a new impetus to the investigation of the biology and habits of animals, *i.e.* animal behaviour.

This line of work—represented in the past by notable contributions such as those by Darwin on earthworms, and by Lubbock on ants, bees, and wasps—has assumed during the last two or three decades a more intensive form, and has afforded a more adequate idea of the living organism as a working entity, and revealed the delicacy of balance which exists between structure, activity, and environment.

The penetrating light of modern investigation is being directed into the organism from its earliest stage. During the summer of 1897 Morgan discovered that the eggs of sea-urchins when placed in a 2 per cent. solution of sodium chloride in sea-water and then transferred to ordinary sea-water would undergo cleavage and give rise to larvæ, and J. Loeb's investigations in this field are familiar to all students of zoology. Artificial parthenogenesis is not restricted to the eggs of invertebrates, for Loeb and others have shown that the eggs of frogs may be made to develop by pricking them with a needle, and from such eggs frogs have been reared until they were fourteen months old. The application of the methods of micro-dissection to the eggs of sea-urchins is leading to a fuller knowledge of the constitution of the egg, of the method of penetration of the sperm, and of the nuclear and cytoplasmic phenomena accompanying maturation and fertilisation, and will no doubt be pursued with the object of arriving at a still closer analysis of the details of fertilisation.

The desire for more minute examination of developing embryos led to the more careful study of the egg-cleavage, so that in cases suitable for this method of investigation each blastomere and its products were followed throughout development, and thus the individual share of the blastomere in the cellular genesis of the various parts of the body was traced. This method had been introduced by Whitman in his thesis on Clepsine (1878), but it was not until after the classical papers of Boveri on Ascaris (1892) and E. B. Wilson on Nereis (1892) that it came into extensive use. For the next twelve or fifteen years, elaborate studies on cell-lineage formed a feature of zoological literature and afforded precise evidence on the mode of origin of the organs and tissues, especially of worms, molluscs, and ascidians. A further result of the intensive study of egg-cleavage has been to bring into prominence the distinction between soma-cells and germ-cells, which in some animals is recognisable at a very early stage, *e.g.* in Miastor at the eight-cell stage. The evidence from this and other animals exhibiting early segregation of germ-cells supports the view that there is a germ-path and a continuity of germ-cells, but the advocates of this view are constrained to admit there are many cases in which up to the present an indication of the early differentiation of the germ-cells has not been forthcoming on investigation, and that the principle cannot be held to be generally established.

A cognate line of progress which has issued from the intensive study of the egg and its development is experimental embryology—devoted to the experimental investigation of the physical and chemical conditions which underlie the transformation of the egg into embryo and adult. By altering first one and then another condition our knowledge of development has been greatly extended. By artificial separation of the blastomeres the power of adjustment and regulation during development has been investigated, and by further exploration of the nature of the egg the presence of substances foreshadowing the relative proportions and positions of future organs has been revealed in certain cases, the most striking of which is the egg of the Ascidian *Cynthia partita* (Conklin, 1905).

Progress in investigation of the egg has been

[1] From the presidential address delivered to Section D (Zoology) of the British Association at Liverpool on September 13.

paralleled by increase in our knowledge of the germ-cells, especially during their maturation into eggs and sperms, the utmost refinements of technique and observation having been brought to bear on these and on other cells. During the last thirty years, and especially during the latter half of this period, cytology has developed so rapidly that it has become one of the most important branches of modern biology. One of the landmarks in its progress was the appearance, at the end of 1896, of E. B. Wilson's book on "The Cell." A great stimulus to cytological work resulted from the rediscovery in 1900 of the principle of heredity published by Mendel in 1865, which showed that a relatively simple conception was sufficient to explain the method of inheritance in the examples chosen for his experiments, for in 1902 Sutton pointed out that an application of the facts then known as to the behaviour of the chromosomes would provide an explanation of the observed facts of Mendelian inheritance. In the same year McClung suggested that the accessory chromosome in the male germ-cells is a sex-determinant. These two papers may be taken as the starting-point of that vast series of researches which have gone far toward the elucidation of two of the great problems of biology—the structural basis of heredity and the nuclear mechanism correlated with sex. The evidence put forward by Morgan and his colleagues, resulting from their work on Drosophila, would seem to permit little possibility of doubt that factors or genes are carried in the chromosomes of the gametes, and that the behaviour of the chromosomes during maturation of the germ-cells and in fertilisation offers a valid explanation of the mode of inheritance of characters. The solution of this great riddle of biology has been arrived at through persistent observation and experiment and by critical analysis of the results from the point of view of the morphologist, the systematist, the cytologist, and the geneticist.

Among other important developments in the period, reference may be made to the great activity in investigating the finer structure of the nerve-cell and its processes. By 1891 the general anatomical relations of nerve-cells and nerve-fibres had been cleared up, largely through the brilliant work of Golgi and Cajal on the brain and spinal cord, and of von Lenhossék, Retzius, and others on the nervous system of annelids and other invertebrates. In these latter had been recognised the receptor cells, the motor or effector cells, and intermediary or internunciary cells interpolated between the receptors and effectors. In June 1891 Waldeyer put forward the neurone theory, the essence of which is that the nerve-cells are independent and that the processes of one cell, though coming into contiguous relation and interlacing with those of another cell, do not pass over into continuity. He founded his views partly upon evidence from embryological researches by His, but chiefly on results obtained from Golgi preparations and from anatomical investigations by Cajal.

The neurone theory aroused sharp controversy, and this stimulus turned many acute observers—zoologists and histologists—to the intimate study of the nerve-cell. First among the able opponents of the theory was Apáthy, whose well-known paper, published in 1897, on the conducting element of the nervous system and its topographical relations to the cells, first made known to us the presence of the neurofibrillar network in the body of the nerve-cell and the neurofibrils in the cell-processes. Apáthy held that the neurofibrillar system formed a continuous network in the central nervous system, and he propounded a new theory of the constitution of the latter, and was supported in his opposition to the neurone theory by Bethe, Nissl, and others. The controversy swung to and fro for some years, but the neurone theory—with certain modifications—seems now to have established itself as a working doctrine. The theory first enunciated as the result of morphological studies receives support from the experimental proof of a slight arrest of the nerve-impulse at the synapse between two neurones, which causes a measurable delay in the transmission.

The latest development in morphological work on nerve-elements is the investigation of the neuromotor system in the Protozoa. Sharp (1914), Yocom (1918), and Taylor (1920), working in Kofoid's laboratory, have examined this mechanism in the ciliates Diplodinium and Euplotes, and they describe and figure a mass—the neuromotorium—from which fibrils pass to the motor organs, to the sensory lip, and, in Diplodinium, to a ring round the œsophagus. The function of the apparatus is apparently not supporting or contractile, but conducting. By the application of the finest methods of microdissection, specimens of Euplotes have been operated upon while they were observed under an oil-immersion objective. Severance of the fibres destroyed co-ordination between the membranelles and the cirri, but other incisions of similar extent made without injuring the fibrillar apparatus did not impair co-ordination, and experiments on Paramæcium by Rees (1922) have yielded similar results. While the experimental evidence is as yet less conclusive than the morphological, it supports the latter in the view that the fibrils have a conducting, co-ordinating function. Progress in our knowledge of the nervous system is but one of many lines of advance in our understanding of the correlation and regulation of the component parts of the animal organism.

The ciliate Protozoa have been the subject during the last twenty years of a series of investigations of great interest, conducted with the purpose of ascertaining whether decline and death depend on inherent factors or on external conditions. While these researches have been in progress we have come to realise more fully that ciliates are by no means simple cells, and that some of them are organisms of highly complex structure. Twenty years ago Calkins succeeded in maintaining a strain of Paramæcium for twenty-three months, during which there were 742 successive divisions or generations, but the strain, which had exhibited signs of depression at intervals of about three months, finally died out, apparently from exhaustion. From this work, and the previous work of Maupas and Hertwig, the opinion became general that ciliates are able to pass through only a limited number of divisions, after which the animals weaken, become abnormal and die, and it was believed that the only way by which death could be averted was by a process of mating or conjugation involving an interchange of nuclear material between the two conjugants

and resulting in a complete reorganisation of the nuclear apparatus. Jennings has shown that conjugation is not necessarily beneficial, that the ex-conjugants vary greatly in vitality and reproductive power, and that in most cases the division rate is less than before conjugation. Woodruff has since May 1, 1907, kept under constant conditions in culture a race of Paramæcium. During the sixteen years there have been some ten thousand generations, and there seems no likelihood of or reason for the death of the race so long as proper conditions are maintained. The possibility of conjugation has been precluded by isolation of the products of division in the main line of the culture, and the conclusion is justifiable that conjugation is not necessary for the continued life of the organism. The criticism that Woodruff's stock might be a non-conjugating race was met by placing the Paramæcia, left over from the direct line of culture, under other conditions, when conjugation was found to occur. Later observations by Erdmann and Woodruff show that a reorganisation of the nuclear apparatus of Paramæcium takes place about every twenty-five to thirty days (forty to fifty generations). This process, termed endomixis (in contrast to amphimixis), seems to be a normal event in the several races of Paramæcium which Erdmann and Woodruff have examined, and it is proved to coincide with the low points or depressions in the rhythm exhibited by Paramæcium.

Enriques (1916) maintained a ciliate—*Glaucoma pyriformis*—through 2701 generations without conjugation, and almost certainly without endomixis. From a single "wild" specimen he raised a large number and found that conjugating pairs were abundant, so that the objection could not be made that this was a non-conjugating race. Enriques then began his culture with one individual, and examined the descendants morning and evening, removing each time a specimen for the succeeding culture. The number of divisions per day varied from nine to thirteen, and as there was no break in the regularity and rapidity of division, and no sort of depression, Enriques concluded that neither endomixis nor conjugation could have occurred, for these processes take some time and would have reduced considerably the rate of division. These results, especially if they are confirmed by cytological study of preserved examples, show that for Glaucoma neither conjugation nor endomixis is necessary for continued healthy existence. Hartmann's observations (1917) on the flagellate *Eudorina elegans* extend the conclusion to another class of Protozoa. He followed this flagellate through 550 generations in two and a half years. The mode of reproduction was purely asexual, and there was no depression and no nuclear reorganisation other than that following fission. The evidence seems sufficient to confirm the view that certain Protozoa, if kept under favourable conditions, can maintain their vigour and divide indefinitely, without either amphimixis or endomixis.

Child (1915) states as the result of his experiments that the rate of metabolism is highest in Paramæcium and other ciliates immediately after fission—"in other words, after fission the animals are physiologically younger than before fission." This view, that rejuvenescence occurs with each fission, derives support from the observations of Enriques and Hartmann, for no other process was found to be taking place and yet the vigour of their organisms in culture was unimpaired. If, then, fission is sufficiently frequent—that is, if the conditions for growth remain favourable—the protoplasm maintains its vigour. If through changes in the external conditions the division rate falls, the rejuvenescence at each fission may not be sufficient to balance the deterioration taking place between the less frequent divisions. Under such conditions endomixis or conjugation may occur with beneficial results in some cases, but if these processes are precluded there is apparently nothing to arrest the progressive decline or "ageing" observed by Maupas and others.

The culture of tissues outside the body is throwing new light on the conditions requisite for the multiplication and differentiation of cells. R. G. Harrison (1907) was the first to devise a successful method by which the growth of somatic cells in culture could be followed under the microscope, and he was able to demonstrate the outgrowth of nerve-fibres from the central nervous tissue of the frog. Burrows (1911), after modifying the technique, cultivated nervous tissue, heart-cells, and mesenchymatous tissue of the chick in blood-plasma and embryonic extract, and this method has become a well-established means of investigation of cell-growth, tissues from the dog, cat, rat, guinea-pig, and man having been successfully grown. One strain of connective tissue-cells (fibroblasts) from the chick has been maintained in culture in vigorous condition for more than ten years—that is, for probably some years longer than would have been the normal length of life of the cells in the fowl. Heart-cells may be grown generation after generation—all traces of the original fragment of tissue having disappeared—the cells forming a thin, rapidly growing, pulsating sheet. Drew (1922) has recently used instead of coagulated plasma a fluid medium containing calcium salts in a colloidal condition, and has obtained successful growth of various tissues from the mouse. He finds that epithelial cells when growing alone remain undifferentiated, but on the addition of connective tissue differentiation soon sets in, squamous epithelium producing keratin, mammary epithelium giving rise to acinous branching structures, and when heart-cells grow in proximity to connective tissue they exhibit typical myofibrillæ, but if the heart-cells grow apart from the connective tissue they form spindle-shaped cells without myofibrillæ.

For many lines of work in modern zoology biochemical methods are obviously essential, and the applications of physics to biology are likewise highly important—*e.g.* in studies of the form and development of organisms and of skeletal structures. Without entering into the vexed question as to whether all responses to stimuli are capable of explanation in terms of chemistry and physics, it is very evident that modern developments have led to the increasing application of chemical and physical methods to biological investigation, and consequently to a closer union between biology, chemistry, and physics. It is clear also that the association of zoology with medicine is in more than one respect becoming progressively closer. Comparative anatomy and embryology, cytology, neurology, genetics, entomology, and parasitology, all have their bearing on human welfare.

Obituary.

Prof. James Sully.

The death of Prof. James Sully, which took place in London on November 2, at eighty-one years of age, removes from among us one of the few survivors of the philosophical school for whom psychology was a mental science distinct from and yet analogous to natural science. His "Teachers' Handbook of Psychology" was for many years the standard text-book of the subject, and his treatise, "The Human Mind" the generally recognised authority on the science. Since he retired in 1903 from the Grote professorship of mind and logic at University College, London, which he had held for ten years, he has lived in retirement. To most of the present generation he is known by the honour accorded to his name in the membership lists of learned societies.

Sully's works on psychology show him still in the main under the influence of the Associationists, Mill and Bain, notwithstanding that he imparted to his subject a wide range of interest. He had no part in the revolution which has overtaken the teaching of psychology. He had studied before the days of laboratory appliances and apparatus for making practical experiments and devising mental tests. Also he was before the rise of psycho-analysis and took no part for or against the medical theories. His particular bent was towards the educational aspect of his subject and his great interest was child-study.

James Sully was born at Bridgwater on March 3, 1842. His parents were Baptists, and he was educated with the intention of preparing himself, should he receive the call, for the Baptist ministry. He went to Taunton Independent College, and afterwards to Regent's Park Baptist College, where he took the London M.A. degree with a gold medal. He then went to Germany, first to Göttingen, and afterwards to Berlin to attend the lectures of Hermann Lotze. He took a post of classical tutor in a Baptist College, but shortly afterwards resigned it and at the same time definitely abandoned the intention of taking a pastorate. Instead he took up journalism. He soon began to make his mark as an author. His book "Pessimism," 1877, gained general recognition as a work of wide and original philosophical interest. Most of his books, however, were technical treatises or handbooks for students. An "Essay on Laughter," 1902, "Italian Travel Sketches," 1912, and quite recently a volume of "Reminiscences" were his last works.

In the time of his full activity Sully lived at Hampstead, the centre of a literary circle which included many well-known names. He was an active member of Leslie Stephen's famous society for Sunday tramps. Among his close personal friends were Henry Sidgwick, Herbert Spencer, G. H. Lewes, Shadworth Hodgson, Cotter Morison, William James and Henry James, and George Meredith.

Dr. E. K. Muspratt.

The death, on September 1, of Dr. Edmund Knowles Muspratt, honorary president of the United Alkali Company Ltd., and a former Pro-Chancellor of the University of Liverpool, is deeply regretted by all who know his public work and intellectual influence.

Born in 1833, the youngest son of James Muspratt, the founder of the great alkali industry of Lancashire, Dr. Muspratt studied chemistry in early life under Liebig, becoming one of his intimate personal friends and following him when he moved from Giessen to Munich. About the year 1856 he entered his father's business, and thus was associated for the rest of his life with the alkali and acid industry of Lancashire, afterwards becoming a director and, later, chairman of the United Alkali Co.

Dr. Muspratt was one of the great citizens of Liverpool who played a leading part in the establishment, first of the University College, and later of the University of Liverpool. A man of wide culture and outlook and a sincere believer in learning and research, he did everything in his power to further the cause of higher education in Liverpool. Together with his friend, the late Sir John Brunner, he was instrumental in obtaining a charter for the new University. For many years he acted as a member of the Council, and by his influential support, wise and broad-minded advice, and generous benefactions, proved himself to be one of the greatest friends the University possessed. Amongst his benefactions may be mentioned the Laboratory of Physical Chemistry, with which his name was associated by the University.

Dr. Muspratt was widely interested in science, literature, music, the drama, politics, and public life. At Seaforth Hall, near Liverpool, his father's home (and also his own to the close of his life), he met many of the most interesting personalities of the time, including Charles Dickens, Samuel Lover, Sheridan Knowles the dramatist (who acted as his godfather), Macready, Douglas Jerrold, Mark Lemon, Miss Charlotte and Miss Susan Cushman. This tradition of culture, friendship, and hospitality was carried on by Dr. Muspratt, so that Seaforth Hall was always the home of wit, learning, and good fellowship.

Dr. Muspratt travelled a great deal in Europe (and in America). In 1917 he published a very interesting and delightful book entitled "My Life and Work."

In the England of fifty years ago there did not exist the great modern "city" Universities of Birmingham, Bristol, Leeds, Liverpool, Manchester, and Sheffield. Their creation in the face of many obstacles and difficulties has been due to the far-sighted vision and true liberalism of a comparatively small number of men. In this select company of great scholars and great English citizens, the name of Edmund Knowles Muspratt holds an honoured and distinguished place.

F. G. D.

Dr. P. W. Latham.

Dr. P. W. Latham, for twenty years Downing professor of medicine at Cambridge, who died on October 29 at Clifton, Bristol, was a notable teacher and practitioner of medicine, working ceaselessly into advanced life for the progress of his science. He died a week after the completion of his ninety-first year. The Downing professorship, entered upon in 1874, was

relinquished in 1894, and five years later Dr. Latham voluntarily resigned from the active staff of Addenbrooke's Hospital, Cambridge. Born at Wigan, in 1832, the eldest son of Dr. John Latham, he was educated there and apprenticed to his father. Later he entered the University of Glasgow, and at Gonville and Caius College, Cambridge. In the first class of the Natural Sciences Tripos of 1859 his sole companion was Henslow the botanist. In the following year he was elected to a fellowship at Downing and proceeded in due course to the degrees of M.B. and M.D. He also studied at St. Bartholomew's Hospital and in Germany.

Dr. Latham's earliest scientific interest after his return to Cambridge was tuberculosis, but in time he passed to the consideration of a wide range of pathological studies and to chemical physiology. His Croonian Lectures in 1886 showed his leaning towards these aspects of medical science; while in the Harveian Oration delivered two years later he lent his support to the advocacy of such theories as those of Koch and Metchnikoff which were rapidly leading to the formulation of modern views concerning disease and tissue reaction. Many of the problems of that time have since been solved; for example, the place of caseous tubercles in the disease complex associated with infection by tubercle bacilli; and some, like that of the transformability of organisms one into another, have been set aside or forgotten. Dr. Latham's hypothesis concerning the molecular structure of living protoplasm, further, was not acceptable; but he assisted notably in the dissemination of scientific ideas of disease and contributed in clear terms, if not prolifically, to current discussions.

By the death of Dr. Charles Proteus Steinmetz, the electrical engineering profession loses one of its most distinguished members. He was born at Breslau in 1865, and after studying at Breslau, Berlin, and Zürich, he went to America. In 1903 he was elected professor of electrical engineering at the Union University, New York. He was a voluminous author, and his books on mathematical electrical engineering are well known all over the world. He was also chief consulting engineer to the General Electric Co. of America and carried out many successful researches. We mention specially his researches on the electric strength of air and on the magnetite arc. As a mathematician he was not widely read, but he displayed great originality. He did much to help the United States to become the leading country in the world in high-tension electrical engineering. On hearing of his death the English Institution of Electrical Engineers in England cabled a message of condolence to the Institute and said that "his work lives and will continue to live."

Current Topics and Events.

MR. ROBERT HUTCHINSON, president of the National Association of British and Irish Millers, read a paper on "The Economic Basis of Wheat-growing in England" at the annual meeting of the fellows of the National Institute of Agricultural Botany on November 2. The only way, he said, of preventing the area under wheat from being further reduced was to raise the price to a profitable level. This is not impossible if a wheat is obtainable which combines with the productivity, the stiffness of straw and the resistance to disease of the best English wheats, the "strength" which puts so high a premium on the best Canadian wheats. "Strength" is the mysterious factor which determines the size, shape, and palatability of a loaf. For many years it was believed that a strong wheat could not be grown on English soils or in the moist English climate. Wheats imported for experimental purposes from Canada, Russia, Hungary and Turkey all lost their quality within a few years. But one wheat, Canadian Red Fife, has been proved to retain its strength unimpaired after 21 successive years' growth in England. Prof. R. H. Biffen, working on Mendelian lines, has proved that strength is a dominant characteristic, and by crossing Red Fife with high-yielding English wheats has already given the farmer Yeoman wheat, which without admixture of foreign wheats will yield satisfactory bread. But, in Prof. Biffen's own words, the sooner Yeoman is off the market the better, for a series of new wheats believed to combine the best characteristics of Canadian and English varieties, and adapted to different types of soils, are now growing at the Cambridge Plant Breeding Institute, and it is hoped to market the first of these through the National Institute of Agricultural Botany in the autumn of 1924. If the promise of these wheats materialises, English wheat will be lifted from the category of kinds to be bought for breadmaking only when the price is low into the category of kinds desired and essential. This change would revolutionise the financial prospects of English wheat-growing.

OF recent years the great development of agricultural education and research in Great Britain has attracted considerable attention throughout the Empire. The number of research workers spending some time at centres such as the Rothamsted Experimental Station is rapidly increasing. In the majority of cases they are sent officially by the Dominion Government concerned. A further example of this co-operation is furnished by the recent departure of Sir John Russell, Director of the Rothamsted Experimental Station, on a special mission to the Sudan. He will be associated with Dr. H. Martin Leake, Director of Agriculture for the United Provinces of India, in advising the Sudan Government on its agricultural policy. In view of the enormous possibilities for growing cotton in the Sudan, agricultural research work will be mainly concerned with cotton. The first instalment of the great irrigation scheme in the Gezira plain south of Khartoum is expected to come into operation in the autumn of 1925. At this stage 300,000 acres will be put under irrigation, of which 100,000 acres will be under cotton; but the total scheme is capable of development over an area

of 3,000,000 acres. In approaching Sir John Russell and Dr. Leake, the Sudan Government has been actuated by the desire to get the best possible advice as to the organisation and direction of the agricultural research work which should be undertaken in connexion with this project, which may ultimately produce 1,000,000 bales of cotton a year. It is hoped that the Empire Cotton Growing Corporation will co-operate with the Sudan Government in the research work to be carried out, and that this work can be co-ordinated with a general plan for research work on cotton problems to be organised throughout the British Empire.

IN the United States National Museum there is an exhibit of the original Patent Office models of the more important dynamos and arc and incandescent lamps which have been invented in America. There are also copies of the original commercial apparatus made after these models. In particular there is a series of incandescent lamps visualising chronologically the development of the Edison lamp from its inception. With this collection in view, Mr. H. Schroeder has written a "History of Electric Light," which has been published by the Smithsonian Institution. The earliest work on filament lamps dates back to 1841, when J. W. Starr, an American, did valuable experimental work and took out patents for "a metallic or carbon conductor intensely heated by the passage of electricity for the purpose of illumination." The carbon pencil operated in a barometric vacuum. An illustration is given of Edison's carbon filament lamp of October 21, 1879, which embodies the main features of the modern filament lamp. No mention is made, however, of the work of Sir Joseph Swan, who developed, between 1878 and 1880, the parchmentised cotton thread filament and ultimately the squirted thread of cellulose, which soon became the universal process. No mention is made of John Hopkinson in connexion with the three-wire system, and we do not agree with the statement on p. 54 that the use of 220-volt lamps is less economical than the use of 110-volt lamps, as they are less efficient. The savings effected in the mains by using the higher pressures have to be taken into account before a decision can be made. The excellent work done by the Germans and Americans in developing the metal filament and gas-filled lamps is well described. The output of electric lamps in the United States alone is 200 millions per annum, and is rapidly increasing.

A SOMEWHAT curious pamphlet has been sent to us by its author, Mr. J. H. Goodchild, of Muswell Hill (London: Simpkin, Marshall and Co.; price 1s.). It bears the attractive title of "Landscape and History"; but the history is that of the rocks which landscape-painters are invited to portray. Mr. Goodchild believes that the ordinary descriptions in geological text-books fail to impress on the mind the continuity of the processes that go on within a rock mass and that make it, at any moment, what it is. He appeals to the artist, with his use of colour, to help the untrained observer to appreciate what he sees. It seems to us that a good deal of description would be required to explain what the painter had striven to represent, and that the current changes and the life-history of the rocks would be much better understood after a few excursions with, say, the Geologists' Association in the field. Mr. Goodchild's views on the origin of "igneous" rocks by segregative processes among the sediments that they appear to penetrate were recently stated in NATURE (vol. 110, p. 589); but how would these processes be expressed by a painter, even if he were gifted with the brain of Leonardo da Vinci and the palette of Tintoretto? The late Mr. Brett was criticised by his fellow-craftsmen because a geologist could always feel sure as to the rocks represented in his fine and vivid pictures of coast-scenery. Mr. Goodchild probably remembers Brett; but he looks farther for an artist of almost supernatural powers, who shall enable us to "visualise"—to use a popular term—the water trickling within a headland of white chalk, or the veins of sulphide ores rusting in confinement underground. We think that we have grasped his meaning; but the pamphlet, even with the aid of its illustrations, possibly does not do full justice to the views that he wishes to propound.

THE publication of Vol. I., No. 1, of the Proceedings of the Cambridge Philosophical Society, Biological Series, is in effect the first appearance of a new biological journal, in which it is proposed to publish research work done at Cambridge in zoology, botany, and physiology. This first number does not perhaps give an adequate idea of the standard of work of this kind which is being done in the University Laboratories, as the papers are all of a rather slight character, and do not include any outstanding scientific discoveries of first-class importance. Dr. D. Klein's account of the structure and life-history of a new type of Schizogregarine parasitic on the larva of a fly is a piece of careful descriptive writing, and is well illustrated. Two papers by Mr. J. T. Saunders dealing with hydrogen ion concentration and the methods of its determination, with applications of these methods to the measurement of the carbon dioxide output of freshwater animals, are useful additions to the rapidly increasing literature on this modern method of biochemical research, and Mr. F. A. Potts's paper on the structure and function of the liver of the ship-worm (Teredo) is suggestive, though not pretending to be an account of a finished research on the subject. There is a short paper by Miss D. Eyden on the vertical distribution of *Daphne pulex* and one by Messrs. F. T. Brooks and W. C. Moore on the invasion of woody tissues by wound parasites, both of which are valuable. The number concludes with a description of a fossil alga from the Middle Cambrian by Mr. J. Walton. The journal, which is issued by the University Press, is well produced, though many will find that the excessive length of the line on the printed page causes the reader unnecessary discomfort.

FOR the benefit of private analysts and others concerned, Mr. C. B. Saunders (National Institute of Agricultural Botany, Cambridge) describes in detail

the methods of seed analysis developed and used at the Official Seed Testing Station. A critical account is given of the various methods of sample-taking and tests for purity and germination, the advantage or otherwise of each being indicated. The various classes of plants, as clovers, grasses, vegetables and cereals, require different treatment in order to obtain the best results in germination tests, questions of substratum, moisture supply and temperature needing separate consideration for each class. In some cases the methods adopted in other countries are described and the reasons given for varying the procedure at the English Official Station. The paper is entirely practical in outlook, all theoretical considerations being reserved for a future handbook on the theory and practice of seed-testing for the use of seed analysts and agricultural students.

By the generosity of Mr. S. Berkeley Smith of Karachi, the Cheltenham Public Museum has acquired on permanent loan one of the largest collections of Chinese porcelain in the provinces. The collection has arrived in 122 packing cases, weighing nearly 5 tons, and has now been arranged for exhibition. It includes a splendid twelve-fold lacquer screen; Céladon and Fanville Rose enamels; Mazarin blue jars; porcelain of the Kang Hsi period (1662-1722); a large and valuable set of plates and bowls of the Ming period (1367–1640). Next we have examples of Imperial Yellow China; the Peach Bloom type, and so-called "Indian Porcelain." The collection of Céladon ware dating back to the Sung Dynasty (960–1250) is specially important. Mr. Berkeley Smith has also sent to Cheltenham some sixty old Chinese pictures. The arrangement in the Museum is well adapted to display this important collection, on the acquisition of which Cheltenham, by the generosity of the donor, is to be warmly congratulated.

The Report of the Earthworks Committee of the Congress of Archæological Societies in union with the Society of Antiquaries is a record of steady progress. Happily, reports of destruction are few and unimportant. The value of the appointment of Mr. O. G. S. Crawford in connexion with the Ordnance Survey is shown in the identification of the sites of earthworks which have been lost sight of, and in archæological county surveys, such as that which has been set on foot in Surrey, and in survey of Welsh Hill Forts, inaugurated by the Board of Celtic Studies of the University of Wales, is fully recognised. The importance of such work is shown by the valuable discoveries made by Mr. E. Hart at Bletchingley, by Mr. Toms at Cissbury Ring, and by the honorary secretary and Mr. G. E. Cruickshank along the course of the Wansdyke, where there appear to be whole groups of settlements hitherto unrecorded. Even in a London suburb Mr. B. Barham has discovered extensive remains of an ancient dyke. Full accounts of the other activities of the Committee in excavation and exploration are given in the Report.

A book of normals of meteorological elements for the British Isles, Section IV., has just been issued by the Meteorological Office, Air Ministry, and published by H.M. Stationery Office. It has been prepared in the hope that it may prove of interest for holiday-makers, to those engaged in agriculture, to doctors and invalids. Average temperatures and the highest and lowest which may be expected, the average amount of rainfall and the number of days with rain, together with the range of variation, are given for each month of the year for 30 selected places. There are frequency tables showing for each month, and for the year, the normal number of days with hail, thunder, snow, and ground-frost. Such health resorts as Bath, Torquay, Brighton, and Eastbourne do not appear in this book of normals, but naturally there must be some limit to the number of places dealt with. An earlier book of normals, Section I., contains many places omitted in the new publication, but Section I. was more for the statistician.

Notice is given that applications for the government grant for scientific investigations for the year 1924 must be sent to the offices of the Royal Society, Burlington House, W.1 (upon forms obtainable from the Clerk to the Government Grant Committee), by, at latest, January 1 next.

A superintendent of agriculture is required by the Department of Agriculture of the Sudan Government. Particulars of the appointment can be obtained from the Inspecting Engineer to the Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W.1. Applications should be marked "Superintendent of Agriculture."

A mycologist is required in connexion with the Ceylon Rubber Research Scheme. Candidates should be honours graduates of a British university with at least one year's post-graduate work in mycology or equivalent qualifications. Further information and application forms may be obtained, upon written request, from the Assistant Private Secretary (Appointments), Colonial Office, Whitehall, S.W.1.

Sir Jagadis Bose, director of the Bose Institute, Calcutta, will deliver a lecture at the Royal Society of Medicine on "Assimilation and Circulation in Plants," on Thursday, December 6, at 5.30 p.m. It will be illustrated on the epidiascope and Sir Jagadis will exhibit his apparatus in operation. The chair will be taken by the president of the Society, Sir William Hale-White.

At the annual general meeting of the Cambridge Philosophical Society held on October 29, the following officers were elected for the session 1923–24:—*President*: Mr. C. T. Heycock. *Vice-Presidents*: Prof. A. C. Seward, Dr. H. Lamb, Mr. J. Barcroft. *Treasurer*: Mr. F. A. Potts. *Secretaries*: Prof. H. F. Baker, Mr. F. W. Aston, Mr. J. Gray. *New Members of the Council*: Mr. F. P. White, Mr. E. V. Appleton, Mr. J. B. S. Haldane.

The ninety-eighth course of juvenile lectures at the Royal Institution to be delivered this Christmas by Sir William Bragg is entitled "Concerning the Nature of Things," and will deal with (1) the atoms of which things are made; (2) the nature of gases;

(3) the nature of liquids; (4), (5), and (6) the nature of crystals—(*a*) diamond; (*b*) ice and snow; (*c*) metals. The first lecture will be given on Thursday, December 27, and the succeeding ones on December 29, 1923, and January 1, 3, 5, and 8, 1924. This will be the first course of lectures to be delivered at the Royal Institution by Sir William Bragg since his appointment by the Board of Managers of the Royal Institution in June last to be Fullerian professor of chemistry and director of the Laboratory and of the Davy-Faraday Research Laboratory.

AT a meeting of the Linnean Society of New South Wales held on August 29, a proposal for the reservation of all areas in New South Wales with altitude greater than 4000 ft. was discussed, and it was resolved "that this Society desires to advocate the reservation from alienation and the more conservative administration of the Crown Lands of New South Wales on which grow the upland forests at the sources of the principal rivers for the following considerations: (1) the quality and regularity of river supply, (2) the preservation of undergrowth and timber, and (3) the preservation of the fauna and flora of scientific value; and that the terms of this resolution be conveyed to the State Government for consideration."

THE governing body of the Imperial College of Tropical Agriculture, realising the need for the provision of scientific workers and technologists if the sugar industry of the British Empire is to be developed and our dependence on foreign countries for our sugar supplies obviated, is establishing and equipping at St. Augustine, Trinidad, a model sugar factory towards which the British Sugar Machinery Manufacturers are contributing plant to the value of 20,000*l*. It is expected that the factory will be completed next year, and meanwhile the governing body has appointed Mr. E. C. Freeland to be professor of sugar technology, and Mr. P. E. Turner to be his assistant and demonstrator. Mr. C. L. Withycombe and Mr. E. E. Cheesman have been appointed demonstrators in zoology and entomology, and botany, respectively.

A COLD snap has recently occurred in many parts of England, and the *Times* of November 9 states that the frost experienced on the previous morning was the sharpest recorded for many years in the early part of November. In the screen the thermometer fell to 19° F. at Leamington, Andover, and Shoeburyness, while on the grass the radiation thermometer registered 11° at Shoeburyness. At Kew, the shade temperature fell to 22° F., which is said to be a "record" for the first ten days of November, being 2° lower than the previous "record" on November 10, 1921. At Greenwich Observatory the thermometer in the screen fell to 23° F. and the radiation thermometer registered 14° F. On November 10, 1908, the thermometer in the screen registered 22° F., which is the lowest temperature at Greenwich for the first ten days of November since 1841, a period of 82 years, while on the grass the radiation temperature was 9° F., which is the lowest radiation temperature at any time in November since 1856, when the thermometer registered 8·5° F. on November 30.

THE Optical Society of America held its eighth annual meeting at Cleveland, Ohio, on October 25, 26, and 27, the business being conducted in the physics building of the Case School of Applied Science. The meetings for the reading of papers were open to non-members, and abstracts of all papers to be read were available before the meetings. Twenty-eight papers were read, including one on the optical problems of an Art Museum, by Mr. F. A. Whiting, director of the Cleveland Museum. Prof. Michelson gave a paper on the limit of accuracy in optical measurement, and Prof. Nichols one on the spectra of incandescent oxides. Seven of the papers dealt with geometrical and general optics, eight with vision, colorimetry and photometry, and the rest with the optics of instruments and with miscellaneous optics. They originated from the Bureau of Standards, the Eastman Research Laboratory, the Research Laboratory of Bausch and Lomb, the Nela Research Laboratory, the Munsell Research Laboratory, the Research Laboratories of the American Telephone and Telegraph Co. and the Western Electric Co., from Frankland Arsenal, and from the laboratories of many of the American universities and technical schools. America is evidently alive to the necessity for research in optics.

PARTICULARS of a very complete series of adjustable resistances of the type consisting of a tube, or in some cases of a block, of rectangular section wound with a single layer of bare wire over which a sliding contact moves, are contained in a new catalogue from the Zenith Manufacturing Co. (Villiers Road, Willesden Green). The range of these has been extended to cover a variety of requirements, from compact laboratory resistances to large switchboard apparatus. Several improvements in design have been made, notably in the way in which the tubes are gripped in their holders and in the clamping on the broad metal rings at the ends, which form the terminals and zero contacts. The resistances can be connected up in a variety of ways and can be wound non-inductively when required. In some cases also it is found convenient to provide them with windings of increasing cross section, by which method some saving in space and material can be obtained, as the section of the conductor can be made to increase approximately at the same rate as the current when the slider is moved to diminish the resistance in circuit.

MESSRS. W. AND G. FOYLE, LTD., 121 Charing Cross Road, W.C.2, have just sent us a copy of the catalogue of their department No. 18, of 569 second-hand books on alchemy, magic art, curiosities, utopias, natural sciences, mining, architecture, mechanics, and their bibliography and literary history. It will repay perusal. A welcome and unusual feature is the inclusion of an index of proper names.

AMONG the announcements of the Oxford University Press is a new edition of "English Industries in the Middle Ages," by L. F. Salzman, in which

will be included much fresh material and many illustrations reproduced from medieval originals. The work will treat of mining, quarrying, building, metal-working, pottery, clothmaking, leather-working, fishing, brewing, and the control of industry.

THE latest catalogue (No. 228) of Messrs. W. Heffer and Sons, Ltd., Cambridge, is an important one. It contains upwards of 1300 titles of second-hand works classified under the following headings: scientific periodicals and transactions of scientific societies, standard scientific books, standard sets and periodicals in English, historical and general literature, foreign literature, oriental literature and journals, and addendum.

THE new announcement list of Messrs. Longmans and Co. gives particulars of the three following books which should be of interest to engineers: "Reinforced Concrete Design," by G. P. Manning, in which the subject-matter is treated from the point of view of the engineer designer. It will include the theory and practice of design as generally admitted and employed at the present day; "Applied Elasticity," by Dr. J. Prescott, written to fill a gap which has existed between the two extremes of English text-books on elasticity. Strict mathematical methods are used wherever these are not too cumbersome, and approximate methods are used to simplify the cumbersome methods; and "The Principles of Irrigation Engineering, with special reference to South Africa," by F. E. Kanthack.

MESSRS. EDWARD ARNOLD AND Co. announce the early publication of "Outlines of Palæontology," by Prof. H. H. Swinnerton, of the University College, Nottingham, in which palæontology is dealt with as a definite branch of science and not as an adjunct to stratigraphical geology, or as a mere division of zoology. The method of treatment adopted arises from the difficulty felt by students of geology and zoology and by others interested in the problems of animal life and evolution in past ages in being able to visualise all the salient characters for which a number of generic or specific names stand sufficiently clearly and completely for the purpose of making mental comparisons. This fact has been borne in mind by the author, and consequently most problems are discussed in terms of organs and structures rather than of organisms and species.

Our Astronomical Column.

TWO COMETS.—A telegram from the Cape announces that Comet Doubiago-Bernard has been observed there, and that the following orbit has been deduced:

$$\begin{aligned} T &= 1923,\ \text{Nov. } 17{\cdot}70 \\ \omega &= 254^\circ\ 32' \\ \Omega &= 227\ \ 36 \\ i &= 114\ \ 17 \\ \log q &= 9{\cdot}8976 \end{aligned}$$

The comet will return north early next year and may possibly be visible with large instruments in February and March. It travelled to nearly 70° S. Decl.

Herr Reinmuth, assistant to Prof. Max Wolf at Königstuhl, Heidelberg, detected a cometary object on October 31 at $8^h\ 44{\cdot}5^m$ local M.T. in R.A. $1^h\ 15^m\ 4^s$, N. Decl. 22° 31′. Daily motion is probably -32^{sec}, north 28′, but as the discovery was made photographically the motion may possibly have been in the reverse direction. The photographic magnitude is given as 13·0. The discovery was made in the course of the minor planet work that is regularly carried on at Königstuhl.

POLARITIES OF SUNSPOTS.—Much interest was caused at the meeting of the Royal Astronomical Society on November 9 by the reading of notes by Prof. Hale and Mr. Ellerman announcing that the Mt. Wilson observations confirmed the reversal of the polarity law for the constituent spots of double groups in the sunspots of the new sunspot cycle. The evidence now suggests that the law persists throughout one 11-year cycle, and is reversed for the following one.

Prof. Newall pointed out that this means the substitution of a 22-year cycle for solar changes, instead of the previously accepted 11-year cycle. He noted that the discovery increased the difficulty in obtaining a mechanical explanation of sunspot phenomena, since the magnetic polarities depend on the directions of the vortex motions round the spots.

THE FIREBALL OF NOVEMBER 3.—This object was observed at 6.53 P.M. at Bristol, Bodmin (Cornwall), and other places, though very few observations of a satisfactory kind have come to hand. Mr. W. F. Denning writes that the real path of the object was directed from north to south, the beginning of the luminous course of the meteor being over the region of Torquay, and the end over the English Channel about 64 miles S.S.E. of Start Point. The radiant point was at 160° + 59° near β Ursæ Majoris, from which point a bright meteor was also seen on October 14 last. This shower appears to be continuous during the last three months of the year. In any case it has been repeatedly observed from the second week of October up to the last week in December.

In the spring months of March and April the same radiant in Ursa Major is manifested with great distinctness. This long continuance or frequent repetition in meteoric radiation deserves further investigation.

SUNSPOTS AND CHANGES IN SOLAR RADIATION.—Prof. Abbot's announcement of the short-period changes in solar radiation was made several years ago. He examines (Proc. Nat. Acad. Sci., U.S.A., Oct. 1923) how far a connexion can be traced between visible changes on the solar disc and the radiation changes. His results are as follows:

1. The appearance of sunspots is accompanied by high radiation, presumably owing to the uprush of hotter matter from the interior.

2. Lower radiation generally occurs just after the central transit of spots.

3. Generally a disturbed solar surface means high radiation, a quiescent surface low radiation.

With regard to (2), he refers to Guthnick's observations of the brightness of Saturn. The fluctuations could be made to accord with the variations of radiation, on the supposition that the radiation is different in different directions, a time-correction being necessary for the difference of longitude of the earth and Saturn. It is suggested that above sunspots there are veiling rays, analogous to the coronal rays, which cause absorption of radiation.

Research Items.

THE "SHRUNKEN HEADS" OF THE JIBAROS.—In "Blood Revenge, War and Victory Feasts of the Jibaro Indians of Eastern Ecuador," by Rafael Karsten, which has been issued as Bulletin 79 of the Bureau of American Ethnology, a section deals with the methods of preparation of, and beliefs attaching to, the shrunken heads which form the war trophies of these tribes. Much attention was attracted to this subject by Sir John Bland-Sutton's lecture before the Royal Society of Medicine in November last (see the *Lancet*, November 11, 1922, p. 995; *Brit. Med. J.*, November 11, 1922, p. 932). These heads, which have been made familiar by a number of specimens in our museums, are usually about the size of an orange, the skin, with the hair attached, having been stripped from the skull by an incision at the back. Three strands of twisted red-painted cotton hang from the lips, and the whole head is dyed with charcoal. The hair, which is held to be the seat of the soul, is the most essential part of the trophy. The head is regarded as charged with supernatural power, and is never that of an enemy belonging to the same tribe as that of the slayer, with whom blood relationship might be claimed, as the process of reduction is a deadly insult to the whole tribe. Each stage of the process has its appropriate ritual. The reduction is begun by the use of three stones heated in a fire, this being obviously ceremonial, as the actual reduction is afterwards effected by the use of hot sand introduced through the opening of the neck. Heads of certain animals such as the sloth and the jaguar, are prepared by the same method and with identical ceremonial, because at one time all animals were men who fought among themselves and took one another's heads as trophies.

POLYNESIAN TYPES.—In vol. xxii., No. 2, of the Journal of the Polynesian Society, Dr. Louis R. Sullivan discusses some of the anthropometric data obtained in the Pacific by the Bayard Dominick Expedition of the Bernice Pauahi Bishop Museum of Honolulu and the American Museum of Natural History. From material collected in Samoa, Tonga, the Marquesas, and Hawaii, Dr. Sullivan has isolated two types which he calls tentatively Polynesian and Indonesian. The characteristics of the Polynesian type are light-brown skin colour, wavy hair, medium development of beard and body hair, lips of average thickness, moderately long head (cephalic index 77-78), high face, high but broad nose, and tall stature; of the Indonesian type, medium to dark-brown skin, wavy hair, scant beard and body hair, thick lips, short heads (cephalic index 81-82), stature shorter than the Polynesian, very low broad face and very low broad nose. This hitherto unsuspected Indonesian element, Dr. Sullivan thinks, explains the often-expressed opinion that the Polynesian and Indonesian are closely related types. When the Indonesian traits are removed, the Polynesian appears to be strikingly Caucasoid, and the available data seem to indicate a type intermediate between Caucasian and Mongol. On the other hand, the Indonesian type seems to be a somewhat doubtful Mongoloid diverging toward the Negrito. This type is most important as an element of the population in Tonga and the North-Western Marquesas. In addition, there is a Melanesian element in the south and west of Polynesia—in Tonga, New Zealand, and Easter Island; but Dr. Sullivan is of the opinion that Melanesian influence has been slightly exaggerated. The group exhibiting a high degree of brachycephaly (cranial index frequently 90 and over), occurring notably in Tonga, Samoa, Tahiti, and to a lesser degree in the Marquesas, to which Prof. Elliot Smith has referred as Proto-Armenoid, he regards as Polynesian with an artificially deformed head.

THE UNKNOWABLE.—It is rather curious to reflect on the completely different aspect which Spencer's theory assumes to us to-day, by reason of the change which has come over our mathematical and physical conceptions. Spencer thought of positive science as a realm of clear and transparent light surrounded by a murky realm of metaphysical darkness, and he expressed this firmly-held conviction by describing the outer darkness as the unknowable. To mathematicians and physicists to-day it is, on the contrary, these outer limits, this beyond of the world of sense-perception, of which they feel most confident that they possess sure and precise knowledge. The electron theory and the principle of relativity, which concern fundamental concepts, seem to us more secure scientifically than the sense-perceived objects of practical life. It is these which have sunk back into the mystery of the unknowable. This is not, however, the line of Mr. Santayana's thought expressed in his Herbert Spencer lecture, "The Unknowable," delivered at Oxford on October 24 and now published (Clarendon Press). For him Spencer's unknowable is a doctrine of substance, and he thinks that when the self-contradictoriness of Spencer's statement is corrected it can be brought into line as a sound Spinozistic conception. "Calling substance unknowable," he says, "is like calling a drum inaudible, for the shrewd reason that what you hear is the sound and not the drum. It is a play on words, and little better than a pun."

METABOLISM IN DIABETES.—A vast mass of data relating to the metabolism of diabetics has been accumulated since 1908 by Dr. E. P. Joslin, of Boston, working in association with Dr. F. G. Benedict, of the Nutrition Laboratory, and these are analysed and discussed in Publication 323 of the Carnegie Institution of Washington. In all, 113 patients have been examined in greater and less detail, partly in the period when the prevalent treatment was overfeeding with a low carbohydrate and high protein-fat diet, and partly since the introduction of fasting and under-nutrition as the general regime in 1914. The figures provide a great quantity of accurate measurements which will be examined with profit by those interested in the subjects.

EFFECT OF MANGANESE ON PLANT GROWTH.—Certain elements that occur only in very small amounts in plant tissues would appear to play some definite part in the economy of the plant. J. S. McHargue (*Journ. Agric. Research*, xxiv. pp. 781-794) has investigated the effect of manganese sulphate on the growth of plants in water cultures with specially purified nutrient salts, and his results indicate that at least for the plants tested, a very small quantity of manganese is essential to produce normal growth. Such plants as radish, soy bean, cow-pea, field pea, and maize do not contain sufficient manganese for growth to maturity, though some have sufficient to maintain a normal development for the first few weeks. In the latter case experiments carried on for too short a time fail to reveal the essential nature of manganese. The lack of manganese affects the production of dry matter and brings about an etiolated condition of the young leaves and buds, suggesting that the element has a function in photosynthesis and in chlorophyll formation. Experiments carried on in soil showed that manganese

sulphate applied to acid soil caused a decrease in crop, whereas if calcium carbonate was applied in addition to neutralise the acidity, increased yields were obtained. Soluble salts of manganese in acid soils may therefore be one of the causes of toxicity in such soils as exhibit toxic effects, an excess of manganese sulphate rendering a soil more or less sterile with respect to the growth of plants.

SILVER-LEAF DISEASE.—The fourth of the series of papers on this subject by Mr. F. T. Brooks and his co-workers appears in the *Journal of Pomology*, Vol. iii., No. 3, September. With financial aid from the Ministry of Agriculture, these important investigations are extending in scope, and besides experiments at Cambridge and at the John Innes Horticultural Institution, Merton, work has been done upon orchard trees at the East Malling Fruit Research Station and at Heston, Middlesex. The parasitic fungus *Stereum purpureum* is responsible for the typical silver-leaf disease, and in this fourth report, Brooks and H. H. Storey criticise Bintner's recent attempt to distinguish a false "silver-leaf" disease due to other physiological causes while pointing out that the silvery appearance, due usually to the optical effects produced by an air gap between leaf epidermis and mesophyll, may frequently arise from accidental disturbances quite unconnected with the entry of *Stereum purpureum*. The experiments now recorded show that the fungus readily infects the living wood at any exposed surface, penetrating such tissues more readily than shoots previously killed in the autoclave, in which it seems to be less active than many saprophytic moulds. A very interesting description is given of the conditions found in Pershore plums which had been infected by the disease and then "grew out" of it. On examination the dead fungus patches could be seen in the wood sharply delimited from the healthy tissues by a band of gum excreted from the tissues. The accumulation of these gum-like substances both in diseased tissues and at the surface of a healthy wound are obviously profitable subjects for further study. Brooks and Storey record many observations on natural wound protection in fruit trees and upon the usual dressings applied to protect such wounds; in their experience gas tar has been the most valuable dressing, Stockholm tar proving very disappointing as a means of protecting wounds against fungal attack.

DISSECTING A DEVONIAN FISH.—A palæontologist of our acquaintance is wont to dream of finding a palæozoic fossil with all its soft parts so beautifully preserved that he can dissect them. Our friend will be envious when he reads in the annual report of the Field Museum of Natural History (Chicago, 1923) how Dr. Erik Stensiö, the new head of the Palæontological Department of the Swedish State Museum, spent ten days at Chicago dissecting the head of a Devonian fish, Macropetalichthys. This specimen, it is said, allowed Dr. Stensiö to obtain an exact knowledge of the shape of the brain and details of the nervous and circulatory system of the head. These facts might possibly have been inferred from the petrified skeletal tissues; but the report says precisely: "The preservation of these soft parts was so perfect that they could be studied almost as well as if it were a fresh specimen." The specimen has been mounted for museum exhibition in such a way as to make a complete whole with all the dissected parts visible, and with every portion removable for close study. Zoologists will await with interest the publication of Dr. Stensiö's memoir.

FREE RADICLES.—J. B. Conant and A. W. Sloan have recently published a preliminary paper on the formation of free radicles (J. Amer. Chem. Soc., vol. 45, p. 2466). The reduction of triphenylpyrylium chloride with vanadous chloride yields a reddish substance which is insoluble in water and behaves as a free radicle. The same reducing agent reduces triphenylcarbinol in concentrated hydrochloric or sulphuric acid solution to free triphenylmethyl.

CELLULOSE DERIVATIVES.—The technology of cellulose derivatives is discussed in an article in the *Chemical Trade Journal* for October 19, which is mainly devoted to the newer ethers and esters. The preparation of cellulose butyrates is receiving attention, because by introducing more complex acid radicals it is hoped to prepare esters with useful solubility properties. The interest in the cellulose ethers has directed attention to improvements in the manufacture of diethyl sulphate, these being discussed in the article. The properties of the various esters and ethers are given.

PRESERVATION OF WOOD.—The *Chemical Trade Journal* for Oct. 5 contains an article on wood preservatives. The art of wood preservation dates back from very early times; it was practised by the Egyptians, who used antiseptic oils for the purpose. Burnett in 1838 introduced the use of zinc chloride; Wolman in 1906 patented the use of certain fluorides in conjunction with other salts, and from this date hundreds of patents on the subject have been taken out. In recent times the creosoting process has been introduced, but it confers odour and inflammability on the timber. The methods of impregnation are discussed in the article, and the results obtained from the uses of various salts are described. A note is also added on the preservation of wood pulp.

MAGNETIC DECLINATION AT KEW.—A careful detailed study by Dr. C. Chree, of the "Absolute daily range of magnetic declination at Kew Observatory, Richmond, 1858 to 1900," has just been published in the Geophysical Memoirs (vol. iii. No. 22) of the Meteorological Office. The annual variation of the daily range is examined by subdividing the year into 73 five-day periods; for each group of five days the 42-year mean daily range is given, also the largest and least values; smoothed means are given also for years of sunspot maximum and minimum. The ranges are, of course, distinctly less in minimum than in maximum sunspot years. The daily range undergoes a double oscillation in the course of a year, with maxima at the equinoxes and minima near the solstices. Again, Wolf's linear relation, $R = a + bS$, connecting the range R with the sunspot number S, is examined; a and b are found to vary quite considerably both throughout the year and from one year to another. The determination of a and b does not in itself give a measure of the degree of correlation between R and S, and this question is separately investigated. The mean correlation coefficient for the whole period is 0·86, but in the mean of the winters it is only 0·53, while there are conspicuous variations in the results for the four groups of years, each roughly comprising one sunspot period, into which the whole series is divided. Interesting frequency tables are also given (*a*) showing the distribution of ranges of different sizes, in each individual year, for the said four groups of years, for sunspot maximum and minimum years, and for each month of the year; and (*b*) showing the distribution of the hour of daily maximum and minimum declination for similar groups of the data. The paper contains a large amount of important though technical information; the results would be more readily comprehended if they had been indicated by graphs based on the numerous tables.

Palæontologists at Vienna.

THE Palæontologische Gesellschaft is an international society of palæontologists, with members belonging to several European nations, to Great Britain, and to the United States. An annual meeting was to have been held in London and Oxford during August 1914, but on account of the War and its effects it was impossible until the present year to hold a meeting outside Germany. Even now the difficulties were only overcome by the aid of the Austrian Government and the generosity of many notable Viennese, who made a meeting in their capital possible for their impoverished colleagues. Thus it was that on September 24 - September 29 a most successful gathering of 53 members and 90 interested persons took place in the University of Vienna under the presidency of Prof. Othenio Abel.

The non-Austrian members included Prof. Wiman of Uppsala, Professors Van Bemmelen and Versluys from Holland, Baron Fejerváry of Buda-Pest, Prof. Pompeckj of Berlin, with 36 German colleagues, Dr. F. A. Bather of the British Museum, and representatives of Czechoslovakia and Jugoslavia.

The congress was honoured in having its session opened in the Festival Hall of the University by the President of the Austrian Republic, Dr. Hainisch, supported by his Vice-chancellor, Dr. F. Frank, Dr. Maurus representing the Minister of Education, and the Rector of the University, Prof. C. Diener. The large gathering listened to an address by Prof. Pompeckj on "The Beginnings of Life," which, in his opinion, took place on the land and not in the sea. Here may be mentioned the dinner in the Rathaus, also attended by the President of the Republic, when speeches of welcome were made by the president of the society and the Deputy-Mayor. The honour of returning thanks on behalf of the foreigners was allotted to Dr. Bather, who dwelt on the power of scientific intercourse to unite the nations, and showed how the advance of science, and notably of palæontology, was retarded by the vexatious barriers still erected by politicians.

The purely scientific programme included the following papers. Baron Fejerváry: The origin of the præ-hallux and the Cheiropterygium theory in the light of palæobiological research; C. Wiman: on some flying Saurians; F. A. Bather: Cothurnocystis, a study in habits and evolution, also Stephanocrinus, a study of convergence; R. Richter: Convergence among Trilobites; H. Schmidt: The development of the Ammonoidea in the Carboniferous; P. Kessler: Nautilids with incomplete septa, which led to a discussion on their mode of life; R. Kubarth: Researches on recent and fossil conifer woods; O. Abel: The first find of a Tetrapod track in the Alpine Trias. The chief interest of the meeting, however, centred in the so-called Drachenhöhle at Mixnitz on the Mur in Steiermark. In this cavern, 1000 metres above the sea, there has been found a remarkable series of cave-bears in all stages of skeletal growth, as well as the remains of smaller mammals associated with them. These have been studied by Prof. Abel and his assistants K. Ehrenberg, O. Antonius, A. Bachofen-Echt, and others. These all described their particular researches, and Prof. Abel in a public lecture drew a vivid picture of the animal life of the "Dragon's Cave."

Opportunity was given to the members to visit Schönbrunn, where the menagerie still contains a fine representation of wild Bovidæ, and the Geological and Mineralogical galleries of the Natural History Museum. An afternoon was devoted to an excursion to the Pallerstein in the Wiener Wald, where the Eocene flysch preserves most curious markings, for the most part of annelid origin. At the close of the meeting 70 members visited the Mixnitz cave, and after spending four hours in the study of its mysteries, were refreshed by a delightful supper and entranced by Styrian folk-songs sung by a choir of local ladies. Fifteen managed on the following day to ascend the Sonnwendstein near Semmering under the guidance of Prof. Kober.

The following have been elected officers for the ensuing year. President: O. Abel (Vienna); Vice-Presidents: O. Jaekel (Greifswald) and E. Stromer (Munich); Secretaries: O. Antonius (Vienna), R. Richter (Frankfort); Treasurer: P. G. Krause (Berlin). New members of Council are F. A. Bather (London) and W. Janensch (Berlin).

The warmest thanks of all who enjoyed this inspiriting gathering are due to Prof. Abel, who, with his colleagues Dr. K. Ehrenberg and Dr. O. Antonius, saw to all the arrangements. Nor should there be forgotten the fine reconstruction of the mammoth made under their direction by the artist Franz Roubal, or the members' badge based thereon by Prof. R. Marschall. The "enkel Bier-abend," where some found a more intimate hospitality in Dr. and Mrs. Abel's home, was a characteristic and delightful feature. But it is more fitting to end with mention of Prof. Abel's "Palæobiologischer Lehrapparat," where he has accumulated a most interesting series of fossils illustrating what one may term their natural history. Nowhere else have we seen this idea so consistently carried out. This room, like the meeting as a whole, was a constant reminder that neither fossils nor those who study them need be dull and lifeless creatures.

Deterioration of Structures in the Sea.[1]

THE investigations on the deterioration of structures of metal, concrete, and timber exposed to the action of sea-water which are being carried out under the direction of a committee of the Institution of Civil Engineers have already formed the subject of two interim reports (see NATURE, October 21, 1920, p. 235, and December 30, 1922, p. 878). The third report, which has just been issued, records progress along several very different lines of research, although, since the phenomena with which they are concerned are slow in developing, conclusive results are not to be looked for in a short space of time.

That part of the work of the committee which deals with the corrosion of metals is the subject of several sections of the report. A full account is given of the arrangements devised for exposing test bars of various types of iron and steel to the action of the sea. The bars, prepared under the supervision of Sir Robert Hadfield and Dr. J. N. Friend, have been despatched to Plymouth, Halifax, Colombo, and Auckland, and reports are given from the engineers in charge at these places describing the methods used for fixing them in position. Groups of bars are to be exposed for five, ten, and fifteen

[1] "The Deterioration of Structures in Sea-Water." Third (Interim) Report of the Committee of the Institution of Civil Engineers. Edited by P. M. Crosthwaite and G. R. Redgrave. Pp. 79. Department of Scientific and Industrial Research (H.M. Stationery Office). Price 3s.

years respectively, after which they will be returned for examination and weighing.

Meanwhile, laboratory work on the same subject is being continued, and the present report includes a short but important communication from Dr. Friend on the influence of strain on the corrodibility of iron and steel, which is of more than merely technical interest. It has long been known that iron, after being subjected to strain, is particularly liable to corrosion, but little exact investigation has been done on the subject. Dr. Friend has carried out a series of experiments on sections cut from bars that had been broken in the tensile tests carried out for the committee. These bars represented seven kinds of wrought-iron and steel, the chemical and physical properties of which had been exactly determined, as well as the degree of strain as measured by the amount of elongation at the points at which the sections were cut. The specimens, isolated on paraffin blocks to prevent any galvanic action, were exposed for a whole year to alternate wetting and drying by tap water in a siphon tank, and the amount of corrosion determined by weighing. The result was, briefly, to show no difference in corrosion between strained and unstrained sections except in the case of a nickel steel (36 per cent. Ni) and less clearly in a chromium steel (13 per cent. Cr). Both these steels, and especially the latter, were very resistant to corrosion, but the percentage difference between strained and unstrained portions is described as "extraordinarily great, resembling in magnitude that observed when strained metals are subjected to acid attack." Dr. Friend is careful to point out that the uniform rates of corrosion in the other irons and steels are not to be taken as contradicting practical experience. In the tests electrolytic action was carefully excluded, but in practice strained and unstrained portions of the metal would be in continuous contact and the difference of potential so produced might well account for the localised and severe corrosion often observed.

A very different field of work is that concerned with the destruction of timber by animal pests, of which the most important are the various kinds of "shipworms" commonly referred to as Teredo. Prof. George Barger reports on experiments in treating wood with various preservatives. The test pieces, after impregnation with the poisonous solutions, were "baited" by attaching a veneer of untreated wood, and were exposed to attack by Teredo at Lowestoft. The most remarkable results were obtained with an arsenic compound, phenarsazine, known in poison-gas warfare under the names "D.M." and "Adamsite." In 1 per cent. alcoholic solution this compound entirely prevented the Teredos from penetrating the test-blocks, although they were numerous in the veneer; even in a dilution of 0·1 per cent. the protection was all but complete.

Mr. C. R. Harington carried out at the Laboratory of the Marine Biological Association at Plymouth some very interesting experiments on the larval development of Teredo. The free-swimming larvæ were kept alive for a fortnight, but attempts to find a suitable food for them failed, and, although they were attracted to and settled on shavings of wood, it was not possible to observe their boring. An important and novel result was the discovery of the manner in which they are attracted to the wood. It was found that alcohol and ether extract from wood a substance which has a strong chemotropic action on the larvæ. Photographs and diagrams are given to show how the larvæ congregate round a small particle of the extract when it is placed in the dish in which they are swimming. Experiments were then made with solutions of various pure substances in capillary glass tubes closed at one end and placed in sea water containing the larvæ. Of the substances tested in this way, malic acid was the only one showing a very pronounced attraction. Whether this is actually the attractive substance occurring in wood, however, has not yet been ascertained.

It is to be noted that neither Prof. Barger nor Mr. Harington mentions by name the species of Teredo used in their experiments, and the possibility that the Lowestoft Teredo may be different from that found at Plymouth is not even referred to. Yet the zoological no less than the physical or chemical data of the experiments deserve to be determined with all possible precision. Closely allied species of animals often differ widely in their physiological reactions. One man's meat is another man's poison, and, although no species of Teredo is likely to grow fat on phenarsazine, it cannot be assumed without trial that a poison efficient at Lowestoft would be equally so at Colombo or even at Plymouth.

A contribution of a very different type is a "Report on Boring Organisms in various Waters" by Mr. J. E. Cunningham of Sydney. It contains a series of statements of the most amazing kind regarding the natural history of Teredo. As an example we may quote the assertion "that full-grown worms will leave a piece of timber and enter another." It is a great pity that the committee should have thought fit to include a report of this character in an official publication.

Invention and Research in Mechanical Engineering.

MANY workers in applied science have an interest in patents and patent law, and to such the remarks made by Sir John Dewrance in his presidential address to the Institution of Mechanical Engineers on October 19 will be of value. Patents and research have occupied a good deal of the president's working life, and consequently they were dealt with very comprehensively in his address.

Some of the large engineering concerns of to-day were started to work patented inventions, but if we look back it is difficult to find very many of these inventions that became the standard productions of the industry when the monopoly expired. It has become increasingly difficult to invent anything that has not been foreshadowed in some previous publication. Patents have gradually become of less importance in mechanical engineering.

Sir John Dewrance has taken out 114 patents; when a definite object is desired, the practice of his firm has been to search its own records to see what has been done before; the Patent Office records are then consulted. Various methods are then evolved and discussed; some of these get no further, whilst others are made, tried, altered, and improved, and the result is exactly what has been felt ought to have been done without all the trouble taken. If the article finds a ready sale, an infringer may adopt the converse process by searching the Patent Office and other records, and producing what is called a mosaic anticipation—one detail is shown in one patent, another in a second, and so on. It has always seemed to Sir John to be unfair that documents should be evidence of anticipation; evidence should be of prior use, and the extent of that use should be sufficient to prevent fraudulent evidence being accepted. The object of a patent specification is that the industry

may be informed exactly how to carry out the invention after the monopoly has expired. If the industry carry out the invention as described, there is ample evidence of use, but in the large proportion of cases the public do not wish to avail themselves of the privilege. Cases are known of specifications being quoted forty years after being filed, during which period there had been no use in accordance with the specification. If the industry has not exercised the privilege of use, and the subsequent inventor has eliminated the defects that prevented the previous patent from coming into use, surely he has good ground for claiming that he has produced a new manner of manufacture.

No less than 16,172 patents were sealed in 1907. Of these 677 were paid up for the sixteenth year in 1922, *i.e.* 4·2 per cent. Of these 677 patents, excluding ordnance, less than 100 related to mechanical engineering. When we realise that only one mechanical patent in 10,000 is worth exploiting, and the industry has to bear the cost in brain power, fees, etc., it seems probable that it would be cheaper for the industry to associate to test designs such as is now being done for research, standardisation, and the other associated activities.

The chief difference between research and invention is that, when conducted by an association of the industry, the results belong to the industry, but the rights of a patented invention belong temporarily to the patentee. The mind of an inventor is liable to exhibit a preference for those designs which may become subject-matter for a patent. The mind of the research worker should be quite free from such restraint, the only object being the best possible result suitable for general adoption and, in some cases, standardisation. It is remarkable that when fixing standards it is seldom, if ever, the British Engineering Standards Committee has wished to adopt an appliance that has been the subject of a patent. The activities of research associations, learned societies, technical colleges, and the British Engineering Standards Association will undoubtedly increase and perform a great many of the duties that in the past were performed by patentees.

Sir John gave an account of the various bodies which are promoting research, and said that it would take too long to give a complete list of the researches in progress—researches that no single firm could carry out wisely or successfully. Such researches can be undertaken only by associations, which those interested ought to assist in every way possible for the benefit of the industry as a whole. Every one who uses knowledge successfully ought to do something to obtain further new knowledge. Sir John desired to impress upon his audience the increasing confidence and hope that, in the future, research will help us to surmount our difficulties. It is of importance that all research workers should realise that by "team" work they must justify and increase this confidence. The nation is watching the result, and critics are not wanting—some are useful and some take a narrow view. We have now opportunities that we never had before, and with British determination we can confidently expect great developments in the future, far exceeding those that have been accomplished in the past.

The New Chemistry.[1]

By Dr. E. F. ARMSTRONG, F.R.S.

IT can be argued that we have just entered on a new stage in chemical investigation. Labours in the main of an analytic type have enabled the exact structure of all but a very few substances to be established: the results have been confirmed by synthetic operations, and most compounds have been built up step by step from their elements. Whilst physicists of the modern school, by a series of most brilliant researches, have learnt much about the nature of the atom, the chemist is now concerned with the behaviour of the molecule. This has entailed the recognition that he has not only to deal with crystals and relatively simple molecules in solution but also to consider actions taking place at the surface of colloid aggregates. As it is probable that the bulk of the reactions in the plant and animal cell are of this nature, their importance will be at once conceded. Further, it must be realised that there is evidence that molecules in solution have a definite space orientation at such colloid surfaces, and indeed according to the work of Hardy at surfaces in general.

According to the accepted space lattice theory of matter, there is a definite attraction causing adhesion between each layer of molecules, and consequently at a surface, say of a piece of glass, there are unsatisfied forces or valencies. At first when a drop of a lubricant is placed on such a surface nothing happens, but when two surfaces of glass are moved over one another the molecules of the lubricant become arranged according to a definite pattern. The chemist to-day, in seeking to explain chemical action, has to realise that this takes place in many instances between aggregates of molecules and at the surface of such aggregates, and not between single simple molecules in solution such as his equations postulate and the ionic theory in its original form demands.

The first fact which has emerged from the detailed study of chemical action at a surface is that the action is not one of the so-called first order in which the same fraction of the reacting substance undergoes changes in successive equal intervals of time—a change expressed graphically by a logarithmic curve. When proper and sufficient care is taken to keep the surface active, the rate of change is uniform, provided that the changing substance is present at the surface in sufficient quantity. These facts are in accord with the hypothesis that action is preceded by the formation of an additive unstable complex which breaks down in all possible ways, that is, into a variety of components, practically as fast as it is formed. The problem of the source of the energy necessary to effect this is not without interest, but it is common to all chemical reactions and its discussion may safely be left to the exponents of the quantum and other theories.

Such actions as we are considering are known as catalytic, the change being effected by virtue of the activity of the catalyst surface, the only other agent involved in practically all cases both in the living cell and the test tube being water. It is now recognised that the water molecule can undergo rupture in two ways, either being distributed upon a single molecule, which is thereby resolved into two others:

$$A.O.B + H.OH = A.OH + B.OH,$$

or divided between two molecules in such manner that whilst the one is oxidised the other is reduced:

$$A + 2H.OH + B = AO + H_2O + BH_2.$$

Entirely different classes of catalysts bring about the two actions, but all are classed as enzymes when

[1] Synopsis of an address delivered to the South Wales Section of the Society of Chemical Industry on November 8.

concerned with changes which take place in the cell. Such enzymes as are well known are highly specific and selective, a different enzyme being required for each class of compound.

Armed with the knowledge of the fundamentals of chemical action in the cell, the time is ripe for the chemist to ascertain the inner meaning of phenomena which the biologist can investigate only by the recording of external visual characteristics. As a case in point, the coloration of flowers and its inheritance may be cited. There is much in favour of the view that flower colours, whether anthocyans or belonging to other groups, are the product of the interaction of two factors, an oxidase and a colourless precursor of the pigment. The absence of either factor means failure to develop colour by the plant, that is, white flowers, and there may also be a third factor present which prevents action taking place between oxidase and leucobase.

If proper combination of effort between the biologist and chemist can be ensured, numerous baffling problems, many of which are of far-reaching economic importance, can be attacked. As illustrating one such, in which that all-essential factor quality is concerned, the puzzling fact well known to agriculturists may be mentioned, that one pasture can fatten stock whereas another is of very little value for this purpose.

University and Educational Intelligence.

CAMBRIDGE.—Dr. Horace Lamb, Trinity College, has been appointed to give the first Rouse Ball lecture on some subject related to mathematical science.

Mr. M. H. A. Newman has been elected a fellow of St. John's College.

It is proposed that the sum of 3030*l.* bequeathed to the University by Mrs. Amy Price Read, shall be devoted to the establishment of a research scholarship similar to the Allen scholarship. In the years when the Allen scholarship is confined to literary subjects of study the Amy Price Read scholarship is to be confined to scientific subjects and vice versa. The scholarship would be open to women students who have been admitted to the titles of degrees on the same terms as to graduates of the University.

LONDON.—The degree of *Ph.D. in Science* has been conferred on Fanny Lowater (Imperial College—Royal College of Science) for a thesis entitled "A Study of the Band Spectrum of Titanium Oxide."

THE use of wireless for university extension work has progressed rapidly in America. Of fifty-seven universities and colleges possessing broadcasting stations at least two—the University of Michigan and Michigan Agricultural College—have organised regular radio extension courses, and the National Radio Chamber of Commerce is developing a plan for establishing other similar courses.

THE Council of Armstrong College, Newcastle-on-Tyne, has appointed Prof. A. S. Ferguson, Ontario, to the chair of philosophy rendered vacant by the departure of Prof. R. F. A. Hoernlé to the University of the Witwatersrand, Johannesburg. Prof. Ferguson is a student of St. Andrews and Oxford, and has contributed articles on Plato to various periodicals.

THE directors of the Leplay House educational visits abroad are taking a group of their members, and others who care to join, to Spain for the Christmas vacation, leaving London December 22, and returning January 6, or with extension January 13. Modern social, economic, and political problems will be touched upon both from the point of view of the peasant life and the city life of to-day. A course of lectures will be included in the programme. Full particulars can be obtained from Miss Margaret Tatton, Leplay House, 65 Belgrave Road, Westminster, S.W.1.

A DEPARTMENT of Geology, Mining, and Metallurgy has been established by the Benares Hindu University under the direction of Prof. N. P. Gandhi. This development was made possible by a gift of Rs. 200,000 by the Maharaja of Jodhpur, who has also endowed a Jodhpur-Hardinge chair of technology. At present the staff of the department comprises two professors—of mining and metallurgy and of geology—an assistant professor of assaying and two demonstrators.

Two travelling fellowships open to women graduates of Great Britain, each of the value of 1000 dollars, are being offered through the British Federation of University Women, 92 Victoria Street, S.W.1. One is offered by the American University Women, to enable the holder to carry on a year's research in any foreign country she may choose. The other, the Rose Sidgwick Memorial fellowship, also endowed by the Americans, offers the same amount to enable a British woman graduate to carry on a year's research or advanced work at an American university, the choice of the university being left to the holder.

IN an article on the Rhodes Scholarships in the *Empire Review* for October, Mr. Ian D. Colvin celebrates the "coming of age" of the great scheme founded in 1902. He remarks that it is yet too young for us to judge of its fruits, as scholars have not yet had time to reach maturity and make their name in the world: he accordingly confines himself to an appreciation of the character of the founder and his aims in founding the scholarships, and a description of the administration of the trust. President Frank Aydelotte, of Swarthmore College, the American Secretary to the Rhodes trustees, is less cautious, having attempted in "Oxford of To-day" an estimate of the influence exerted by the American Rhodes scholars. In the first place he points out that they have, almost to a man, returned to America, and there is a consensus of opinion that they go back better Americans for their Oxford experience. Only one of them has become a British subject. More than a third of them are engaged in educational work, and of these many are already college professors, deans, and presidents. "Perhaps there is no career in the United States at the present time which represents more accurately what Rhodes thought of as public life, no career which offers a better opportunity to influence public opinion than that of professor or administrative officer in one of our American colleges or universities." One of them is United States Commissioner of Education, and as head of the Washington Bureau undoubtedly exercises very great influence. No account such as President Aydelotte has given for the Americans seems to have been published regarding the careers after leaving Oxford of the other Rhodes scholars. It is known, however, that an occupational census of those who were elected to scholarships up to 1916 gave the following percentages: educational work 32, law 25, business and industry 11, administration and other government service 8, medicine 7, ministers of religion 4, farming 3, social and philanthropic work $1\frac{1}{2}$, journalism and publishing $1\frac{1}{2}$, engineering and mining $1\frac{1}{2}$, other occupations 5.

Societies and Academies.

LONDON.

Royal Society, November 8.—A. S. **Parkes**: Studies on the sex-ratio and related phenomena—fœtal retrogression in mice. By means of *corpora lutea* counts it was found that in mice the average amount of fœtal mortality leading to retrogression was 10·8 per 100 normal fœtuses. Daniel and King have shown for mice and rats respectively that the does may become pregnant at the œstrus period which follows within twenty-four hours after parturition, and that the gestation period of the second litter is prolonged in some cases as much as ten days. This abnormal prolongation of the embryonic stages, which is due to inhibited implantation in the uterine *mucosa*, can be used experimentally to determine the effect of unusually adverse conditions upon embryonic and fœtal mortality. Where the previous young were suckled less than six days, the amount of mortality rose to 17·6 per 100 normal fœtuses, while in prolonged gestations resulting from continued suckling of previous young, the amount of mortality was further increased to 23·1. The sex-ratio of young born in these two classes was respectively 80·4 and 62·1 males per 100 females. Since the normal sex-ratio of mice is not far from equality, this inverse correlation between the amount of fœtal mortality and the sex-ratio of the surviving fœtuses suggests that mortality during gestation falls preponderatingly upon the males.—R. A. **Fisher**: The influence of rainfall on the yield of wheat. The Rothamsted data for rainfall and wheat yields extend to 1854; these data have been utilised to calculate the average effect on the yield of rain at different periods of the harvest year, for plots under 13 different manurial treatments. An extension of the method of partial correlation, applicable when the number of independent variates is very large and can be arranged in a continuous series, is used. The several plots show marked differences in their response to rain, showing that it is not impossible for the farmer to adapt his manurial treatment to a wet or dry season. A large part of the differences may be ascribed to the effects of loss of soil nitrates by percolation; other effects not susceptible to this explanation, and not hitherto anticipated, include the losses on the highly nitrogenous plots due to late summer rain. The residual value of artificial nitrogenous manures appears from these results to be considerably greater than has been thought.—D. **Thursby-Pelham**: The placentation of *Hyrax Capensis*. The early development of Hyrax is unknown, but there is no embedding of the blastocyst which undergoes its development in the uterine lumen. The maternal epithelium is destroyed early by the trophoblast on all sides. The trophoblast is differentiated into two cytotrophoblastic layers:—(1) basal phagocytic layer (basal trophoblast); (2) cellular network enclosing lacunæ of maternal blood (inner trophoblast). The placentation throws little light on the affinities of Hyrax. While it agrees with the placenta of rodents in being hæmochorial, it differs in its zonary form and the detailed character of its trophoblast. Superficially it bears some resemblance to the placenta of Elephas in zonary arrangement and great complexity of allantoic villi, but in Hyrax there is no syncytial layer of maternal tissue surrounding the villi as in Elephas. Our present knowledge of the placentation of Hyrax tends to emphasise the isolated position the order occupies among Eutheria.

Physical Society, October 26.—Dr. Alexander Russell in the chair.—S. H. **Piper** and E. N. **Grindley**: The fine structure of some sodium salts of the fatty acids in soap curds. X-ray photographs of certain sodium salts of the fatty acids (soap curds) show lines due to reflections from planes with very wide spacings of the order 40 Å.U. These planar spacings increase uniformly with the number of CH_2 groups in the molecule, indicating an effective length of 1·25 Å.U. for the CH_2 group. These and other lines can be accounted for by assuming that the curds are in the smectic state described by Friedel.—E. A. **Owen** and G. D. **Preston**: X-ray analysis of solid solutions. The atomic structure of solid solutions of copper-aluminium, aluminium-magnesium, and copper-nickel has been examined by the X-ray spectrometer. In each case it was found that the solute atom replaces an atom in the lattice of the solvent, the substitution being accompanied by a distortion of the lattice. The eutectic alloy of aluminium and copper consists of a mixture of two distinct substances with different space lattices, one being $CuAl_2$ and the other a substance the space lattice of which cannot be distinguished from that of pure aluminium. The intermetallic compound $CuAl_2$ possesses a simple tetragonal lattice of side 4·28 Å.U. and axial ratio 0·562, the copper atoms being at the corners and the aluminium atoms at the centres of the four small faces. The atomic structure of the compound CuAl resembles that of a solid solution of aluminium in copper, but the distortion is considerably greater. The material has a face centred trigonal lattice of side 3·89 Å.U. and an angle between the axes of 94·6°, the 111 planes being composed alternately of aluminium and copper atoms.—H. **Chatley**: Cohesion. The consequences are discussed of assuming that the alternately positive and negative atoms in a crystal may be treated as doublets attracting according to an inverse fourth-power law, while the electron fields surrounding the atomic nuclei repel according to an inverse tenth-power law. The numerical results agree fairly well with the facts as regards the strain which produces rupture in solids, and as regards the rate of change of compressibility with compression in liquids.

Linnean Society, November 1.—Dr. A. B. Rendle, president, in the chair.—S. **Garside**: The forms of *Hypoxis stellata*, Linn. f., a South African species of Amaryllidaceæ. Four varieties are distinguished, one of these as yet undescribed. In each case the varieties have constant vegetative characters, but the flowers show a considerable range of colour variation of a "continuous" kind. Important cytological characters of the upper epidermis of the perianth lobes were described, with particular reference to the remarkable iridescent areas which occur in some varieties. Habitat may considerably influence the size of the plant, but the varietal characters remain constant.—H. A. **Baylis**: The host-distribution of parasitic thread-worms (nematodes). The nematodes parasitic in vertebrates show great variety in the extent to which they are limited to particular hosts. They may be divided broadly into a section with more or less strict "specificity" and a section with members occurring in various hosts, often of quite distantly related groups. Many of the latter have an intermediate host (commonly an invertebrate) during their earlier phases, and these forms, being introduced into the final host at a more advanced stage than those which have a direct development, may be better able to adapt themselves to a variety of final hosts. Among forms with a direct development, those which show the strictest specificity are probably the most specialised, this being often correlated with specialisation, in habits

or otherwise, of the hosts, while those which have a wide range have retained a primitive adaptability.—W. N. **Edwards**: On the cuticular structure of the Devonian plant Psilophyton. Specimens of *Psilophyton princeps*, Dawson, from Gaspé (New Brunswick) in which the cuticle is preserved, show that as in the early land plants of the Rhynie Chert the stem is provided with stomata. These resemble in size and distribution the stomata of Asteroxylon but have cuticle thickenings. No stomata were seen on the highly cuticularised spines, but these spines do not resemble intumescences of Rhynia, and Psilophyton is probably nearer to Asteroxylon.

Aristotelian Society, November 5.—Prof. T. Percy Nunn, president, in the chair.—T. P. **Nunn**: (Presidential address) Scientific objects and common-sense things. The greatest achievement of the physical sciences is generally held to be the discovery, behind the veil of common-sense things and observable events, of a world of scientific objects and unobservable events. The primary qualities of common-sense things are transferred without difficulty to scientific objects. Size, mass, and motion, for example, belong to an electron in the same sense in which they belong to a flying bullet or to a planet. Their materiality being thus assumed, these objects have constantly increased their hold upon the scientific mind. The philosophical question involved in this concept is whether objects can exist which only possess the primary qualities of common-sense things and have none of their secondary qualities. To resolve this problem we must have a satisfactory theory of the common-sense thing. Such a theory is that a thing is a structure embracing and actually consisting of all the sense-data which common-sense regards as qualities of the thing and are presented to any percipient at any time or place. Unless this doctrine is hopelessly wrong, tne pretension that scientific objects are the reality of which the common-sense world is but the appearance, must be entirely abandoned. The real achievement of science is not to have disclosed any reality behind the veil of sensible things, but to have greatly extended and deepened and rationalised the scheme of the world revealed in perception.

Ipswich.

Prehistoric Society of East Anglia (Autumn London meeting), October 10.—H. **Bury** (Presidential address): The distribution of palæoliths in the Hampshire basin, with special reference to a "palæolithic horizon" separating levels at which implements are common from those in which they are extremely rare. This horizon indicates the highest altitude reached by the rivers in palæolithic times; the implements found at higher levels were buried during glacial conditions, when the normal drainage was temporarily obliterated. The differences in the level of the horizon in the Hampshire, Thames, and Somme Basins respectively (150 to 130 feet) are due to changes in the position of the river mouths, and not to local warpings of the earth's crust. There is clear evidence from the New Forest and Bournemouth Plateaux that the river fell and rose again in Lower Palæolithic times, the total range of movement (100 feet) agreeing exactly with the change from the third to the first terrace of the Somme, which Commont attributes to the Chellean period. But the English evidence makes it clear that tne subsequent rise of the river (in or after Acheulean times) was much higher than Commont admits, and reached the extreme level of the Palæolithic horizon. The corresponding sea-level is more difficult to ascertain, but evidence from the Isle of Wight points to 120 feet O.D.—M. C. **Burkitt**: The discovery in northern Spain of an industry which appears to be transitional between those of the late palæolithic and the opening of the neolithic ages. Masses of shells cemented to the roofs of certain caves on the coast of the Asturias are accompanied by a stone hand-pick made from a flat pebble fluted to a point, the butt and under side being unworked. This implement is found with the accompanying shell middens to overlay deposits containing the typical harpoons of the Azilian industry, and is evidently earlier than the early neolithic stage.—L. **Armstrong**: The excavations undertaken at Grimes' Graves, Norfolk, during the past summer. A survey of the site was made in 1922 to ascertain the level at which the floor-stone flint worked by the prehistoric miners outcropped in the adjoining valley. This season, aided by a grant from the Percy Sladen Memorial Trust, excavations were made with the view of determining whether a phase of mining could be traced on the hill slope earlier than the large galleried pits sunk from the top of the adjoining hill. A type of flint mine was discovered in which the radiating galleries were absent; descent was made by aid of rough steps left in the chalk; these were excavated by small hand-picks of splintered bone, which in one case was human. No trace of these pits can be detected on the surface; they are filled with an extremely compact deposit of chalk. Thus they are in direct contrast to the conditions in the long-known pits of Grimes' Graves, which seems to indicate a more ancient period of working. A glacial disturbance of the sides of the valley has thrust up a series of blocks of the flint towards the surface, which would probably attract the attention of the flint hunters.—A. G. **Wade**: Ancient flint-mines at Stoke Down, Sussex (*v.* Nature, October 20, p. 597).

Paris.

Academy of Sciences, October 22.—M. Albin Haller in the chair.—H. **Deslandres**: An equatorial of a new type, named the table equatorial, intended especially for researches in physical astronomy.—A. **Châtelet**: The properties of finite Abelian groups.—A. **Bloch**: The paratactic circles and the cyclid of Dupin.—M. **Hadamard**: Remarks on the preceding communication.—Maurice **Gevrey**: Some properties of quasi-analytical functions of one or more variables.—Harald **Bohr**: Nearly periodic functions.—G. **Valiron**: The theorem of Picard-Borel.—A. **Guillet**: The synchronisation of circular movements.—M. **Huguenard**: A method for the absolute measurement of the velocity of a current of air. This method utilises a novel principle. During the passage of an electric spark in air, in addition to the sound-wave, a little cloud of warm air is formed which can be rendered visible by means of a second spark placed on the axis of the first. If the air is moving, this cloud is carried along at the velocity of the air current and its position determined by eye for low velocities or photographically for high velocities. A diagram and description of the apparatus is given: it is not necessary to know the temperature or pressure of the gas nor the velocity of sound, and very high velocities can be readily measured by this method.—Marius **Pascal**: Observations on the note by M. P. Noaillon on "Superficial circulation."—P. **Idrac**: The structure of sea winds and their utilisation for hovering flight. A summary of the results of experiments on the movements of air currents over the sea, carried out during the autumn at the lighthouse of Jument d'Ouessant.—Alex. **Véronnet**: The evolution of the trajectory of a star in a resistant medium.

—W. W. **Heinrich**: The analytical prolongations of the limited problem.—Ladislas **Gorczinski**: The diminution of intensity in the red portion of the solar radiation, observed in Europe and at the equator. The measurements were made with bi-metallic actinometers (Michelson system) furnished with coloured glasses. Between the equator and latitude 52° N. there is a progressive increase in the intensity of the red portion of the solar radiation as the distance from the equator increases.—P. **Lambert**, G. **Déjardin**, and D. **Chalonge**: An attempt to prove the existence, at high altitude, of a solar radiation in the extreme ultra-violet. Photographs of the solar spectrum were made with a specially designed spectrograph at the Vallot Observatory at the summit of Mt. Blanc, the experiments being specially directed to detect ultra-violet light between the wave lengths 1900 Å. and 2150 Å. The results were negative, no impression being shown by the plate after 40 minutes' exposure. It is suggested that oxygen may possess absorption bands in this region, and this point is to be the subject of further experiments.—F. **Wolfers**: The diffusion of the X-rays and Bragg's law. The work of Stenström, Siegbahn, Hjalmar, and Duane and Patterson has shown that Bragg's law, $\kappa\lambda = 2a \sin \alpha$ is not rigorously true, the angles measured in the higher orders being a little too small. The author shows that it is possible to explain these deviations in a manner compatible with the quanta theory, assuming only that diffusion in a crystal of any substance is of the same nature. The deviations calculated from the theory thus developed are compared with the measurements of Hjalmar.—E. **Darmois** and J. **Périn**: Cryoscopy in $Na_2SO_4 . 10H_2O$. The molecular magnitude of the malates, molybdates, and molybdomalates. Cryscopic measurements show that these complex molybdic acids are all derived from two molecules of malic acid.—Paul **Pascal**: The constitution and evolution of the metallic oxides and hydroxides. Magnetic analysis serves to distinguish water of hydration from water of constitution. Applications of the method to the cases of cadmium hydroxide, magnesium hydroxide, and zinc hydroxide are given in detail.—P. **Brenans** and C. **Prost**: The *p*-iodoxybenzoic acids. Description of the preparation of the iodo- derivatives of para-oxybenzoic acid, $C_6H_3I(OH)(CO.OH)$ (3:4:1) and $C_6H_2I_2$ (OH)(CO.OH) (3,5 : 4 : 1).—E. **Kohn-Abrest** and J. **Ricardoni**: A new method of estimating hydrocyanic acid in cyanogenetic plants. The hydrocyanic acid is removed from the cold solution by means of a current of air passed for a period of eight hours.—A. **Baldit**: The trajectories of storms and their splitting up into two.—Marc **Bridel** and Pierre **Delauney**: The properties of loroglossin and its products of hydrolysis: glucose and loroglossigenine. Loroglossin, under the action of emulsin, gives glucose and a new substance, loroglossigenine. The latter has been obtained in the crystalline form, but in a quantity too small for complete analysis.—C. **Fromageot**: The influence of the concentration of salts in sea water on the assimilation of green Algae. The intensity of the photosynthesis varies appreciably with the concentration of the medium. There is an optimum saline concentration for the photosynthesis, and this concentration is precisely that of sea water.—F. W. T. **Hunger**: The nature of the cocoanut pearl and its formation.—Georges **Claude**: The transformation of ammonia into fertiliser.—J. **Athanasiu**: The nervous motive energy of the heart and the nature of the contraction of the myocardium.—Charles **Benoit** and André **Helbronner**: The antagonism of radiations. Physiological and therapeutic consequences. In the field of physiology, the effect of irradiation by ultra-violet light is increased both in intensity and rapidity by a preliminary infra-red irradiation. On the other hand, the effects tend to be neutralised by a subsequent infra-red irradiation.—Jacques **Pellegrin**: A new apodal fish from the Bay of California, and its biology.—J. **Legendre**: The zoophilia of certain mosquitoes and its application to prophylaxy. In some regions *Culex pipiens* and *Anopheles maculipennis* both attack man, but it has been noted that at a coast station in Brittany, where these species are present together, neither attacks man. It is suggested that one of these insects might be used to suppress the other, and an experiment in this direction has been started.—A. **Vandel**: The existence and conditions of parthenogenesis in a terrestrial Isopod: *Trichoniscus* (*Spiloniscus*) *provisorius*.—A. **Desgrez**, H. **Bierry**, and F. **Rathery**: The utility of vitamin B and of levulose in the cure by insulin. The transitory effect of insulin in diabetes may be increased and prolonged by a suitable food regime. The addition of either vitamin B or levulose, or a mixture of both, allows the insulin injections to be made at longer intervals and thus increases the useful effect of a given amount of this substance.—Mme. J. Samuel **Lattès**: The corpuscular nature of the radiation responsible for the phenomenon of necrosis (produced by the X-rays) and on the best thickness of the filters.—M. **Sluys**: The creation of multiple foci of the secondary β-radiation in the middle of the tissues for a therapeutic purpose.—Charles **Richet** and Jean **Célice**: Local sera therapy in acute infantile gastro-enteritis.

SYDNEY.

Linnean Society of New South Wales, August 29.—Mr. A. F. Basset Hull, president, in the chair.—Vera **Irwin-Smith**: Studies in life-histories of Australian Diptera Brachycera. ii. Asilidæ. No. 1. Catalogue of the species of Asilidæ of which the earlier stages have been recorded. Asilidæ. No. 2. Notes on the egg-laying, eggs and young larvæ of *Neoaratus hercules* Wied. Larvæ were hatched from eggs laid by a female in captivity. The eggs were 1·1-1·2 mm. long and 0·40-0·43 mm. broad, and the newly-hatched larvæ were 2·2-2·6 mm. long. The eggs are distinguished by a characteristic pattern in dark pigment on the inner layer of the shell.—J. **McLuckie**: Studies in symbiosis. v. A contribution to the physiology of *Gastrodia sesamoides* (R.Br.). An account of the mycorhiza and the bacteria associated with the rhizomes of the species, and their relation to the higher plant. The nutritive phase of the association of fungal hyphæ, bacteria and Orchid is also discussed.—J. M. **Petrie**: Studies in plant pigments. i. The yellow colouring-matter of the Acacias. Four different species of Acacia (*A. discolor*, *A. linifolia*, *A. decurrens* and *A. longifolia*) have been examined to ascertain the nature of the colouring matter of their yellow inflorescences. The water soluble yellow pigment was a glucoside of kæmpferol, which exists in the flowers as a rhamnose glucoside; no free flavonol was found. The Acacia tannins were composed of phloroglucinol, protocatechuic and gallic acids and deposited on hydrolysis large amounts of red phlobaphene anhydrides. The carotin and xanthophyll as plastid pigments were present in amounts from 0·14 to 0·3 per cent., and the flavonol about 0·06 per cent. of the fresh flowers.—E. W. **Ferguson**: Revision of the Amycterides (Coleoptera). Pt. viii. The Euomides. There is no single character separating this group from the remainder of the subfamily. All the described species are reviewed and in many cases redescribed from the types. The descriptions of ten new species and two new varieties are included.

Official Publications Received.

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 31: Americanization in the United States. By Prof. John J. Mahoney. Pp. iv+42. (Washington: Government Printing Office.) 5 cents.

Year Book of the Royal Society of Tropical Medicine and Hygiene. Session 1923-24. Pp. 27+iv. (London: 11 Chandos Street, W.1.)

Publications of the American Astronomical Society. Vol. 4. Pp. iv+432+8 plates. (Madison, Wis.: Washburn Observatory.) 2 dollars.

The Parliament of the Commonwealth of Australia, 1923 (Second Session). Meteorological Service. Report to the Honorable the Minister for Home and Territories on the Work of the Meteorological Service for the Financial Year 1921-22. By H. A. Hunt. Pp. 81. (Melbourne: Albert J. Mullett.) 1s. 3d.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 53, January to June. Pp. 262. (London: 50 Great Russell Street, W.C.1.) 15s. net.

Ministry of Public Works, Egypt. Report on the Work of the Physical Department for the Year ending March 31st, 1923. By Dr. H. E. Hurst. Pp. 25. (Cairo: Government Publications Office.) P.T. 5.

Ministry of Public Works, Egypt. Zoological Service, Publication No. 36: Report on the Zoological Service for the Year 1922, in which is included the 24th Annual Report of the Giza Zoological Gardens. By Major S. S. Flower. Pp. 26. Zoological Service, Publication No. 37: List of Birds of Prey 1898-1923, with Notes on their Longevity. By Major S. S. Flower. Pp. 46. (Cairo: Government Publications Office.) P.T. 5 each.

Departement van Landbouw, Nijverheid en Handel. "'S Lands Plantentuin" ("Jardin Botanique de Buitenzorg"). Treubia: Recueil de Travaux Zoologiques, Hydrobiologiques et Océanographiques. Vol. 4, Livraison 1-4: Meteorological and Hydrographical Observations made in the Western Part of the Netherlands East Indian Archipelago. By K. M. van Weel. Pp. 559+9 plates+28 charts. (Batavia: Drukkerijen Ruygrok & Co.)

Abstract-Bulletin of Nela Research Laboratory, National Lamp Works of General Electric Company, Cleveland, Ohio. Vol. 1, No. 3, October 1922. Pp. ix+303-521. (Cleveland, Ohio.)

Proceedings of the Liverpool Geological Society. Session the Sixty-fourth, 1922-1923. Part 4, Vol. 13. Edited by C. B. Travis. Pp. xviii+231-341. (Liverpool.)

The Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts. Year Book, 1923. Pp. 195. (Philadelphia.)

Edinburgh University and the East of Scotland College of Agriculture: Animal Breeding Research Department. Report of the Director for the Year ending 30th June 1923. Pp. 16. (Edinburgh.)

Diary of Societies.

SATURDAY, NOVEMBER 17.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11.—Miss R. Bracher: Observations on Rhytisma.—J. J. Clarke: Notes on some Mycological Chromidia.—W. J. Dowson: A Mould attacking Sweet Peas.—Dr. A. S. Horne and G. H. Jones: Further Contributions to the Study of Eidamia.—R. Paulson: Observations on Tree Mycorrhiza.—A. A. Pearson: A Foray in Paris.

BRITISH PSYCHOLOGICAL SOCIETY (General Meeting conjointly with the Æsthetic Section) (at King's College), at 3.15.—R. Fry: What Artists want from Psycho-Analysis.

MONDAY, NOVEMBER 19.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—A. B. Eason and others: Discussion on Power in Telephone Exchanges.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Prof. T. P. Nunn: The Philosophy of Signor Gentile.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 7.—Special Exhibition of Industrial Kinematograph Films.

ROYAL INSTITUTE OF BRITISH ARCHITECTS (at 1 Wimpole Street), at 8.—G. T. Forrest: The Rebuilding of Ypres.

ROYAL SOCIETY OF ARTS, at 8.—S. H. Davies: The Cultivation of Cocoa in British Tropical Colonies.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Count Byron de Prorok: Results of Recent Research at Carthage.

TUESDAY, NOVEMBER 20.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—E. Gosse: Personal Relations between Medicine and Literature (David Lloyd Roberts Lecture).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: (1) Report on the Additions to the Society's Menagerie during the month of October 1923; (2) Exhibition of a Collection of Autographs recently presented the Society by Mr. Hugh S. Gladstone.—W. E. Le Gros Clark: Notes on the Living Tarsier.—Dr. Francis, Baron Nopsca: Reversible and Irreversible Evolution; a Study based on Reptiles.—Dr. J. R. Garrood: Two Skeletons of the Cetacean *Pseudorca crassidens* from Thorney Fen, Cambridgeshire.—Dr. C. Crossland: Polychæta of Tropical East Africa, the Red Sea, and Cape Verde Islands; and of the Maldive Archipelago.—Miss Joan B. Procter: (1) New and Rare Reptiles from South America; (2) New and Rare Reptiles and Batrachians from the Australian Region.

INSTITUTION OF CIVIL ENGINEERS, at 6.—R. F. Grantham: The Effect of Groyning on Some Parts of the English Coast.—E. W. Hollingworth: The Tides from an Engineer's Standpoint.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—H. Campbell: The Gas Turbine.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Meeting organised by the Scientific and Technical Group.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—L. H. Dudley Buxton: The Inhabitants of Inner Mongolia.

CIRCLE OF SCIENTIFIC, TECHNICAL, AND TRADE JOURNALISTS, at 8.15.—Sir Richard Gregory: Progress in Science and Invention.

WEDNESDAY, NOVEMBER 21.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL METEOROLOGICAL SOCIETY, at 5.—L. F. Richardson: Attempts to measure Air Temperature by shooting Spheres upward.—Col. H. G. Lyons: Exhibit of a Replica of an Early Korean Raingauge.—F. J. W. Whipple: Exhibit of a Limit-gauge for Rainfall.—S. N. Sen: The Distribution of Air Density over the Globe.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. L. J. Wills: The Development of the Severn Valley in the Neighbourhood of Ironbridge and Bridgnorth.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—H. H. Mardon: Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Dr. E. V. Appleton and F. S. Thompson: Periodic Trigger Reception.—R. C. Clinker: A Dynamic Model of a Valve and Oscillating Circuit.

INSTITUTION OF PRODUCTION ENGINEERS (at Engineers' Club), at 7.30.—A. W. Swan: The Use of Charts in Engineering.

ROYAL MICROSCOPICAL SOCIETY, at 7.45.—F. R. Brambell: Sex-Reversal and Intersexuality.—Prof. J. Bronte Gatenby: Further Evidence on the Transition of Peritoneal Cells into Germ-Cells in Amphibia.—Dr. M. Johnston: The Preparation of Eel Scales for Microscopic Examination.—F. I. G. Rawlins: The Microscope in Physics.—Dr. H. M. Woodcock: Exhibition of Bacteriomorphic Granules (or Granules Simulating Bacteria) resulting from Cell-lysis or Digestion.

ROYAL SOCIETY OF ARTS, at 8.—A. Knowles: Forgeries of Ancient Stained Glass.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, NOVEMBER 22.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at 11 Chandos Street, W.1), at 2.45.—Prof. D. C. Winckler: The Psychiatrical and Neurological Teaching at the Dutch Universities, especially at the University of Utrecht.

ROYAL SOCIETY, at 4.—Special General Meeting to consider the Annual Report of Council.—At 4.30.—F. Simeon: The Carbon Arc Spectrum in the Extreme Ultra-Violet, II.—H. J. Gough and Dr. D. Hanson: The Behaviour of Metals subjected to Repeated Stresses.—W. Suckamith and L. F. Bates: A Null Method of Measuring the Gyro-Magnetic Ratio.—J. H. Shaxby: Studies in Brownian Movement, II. The Determination of Avogadro's Number from Observations on Bacteria (Cocci).—*To be read in title only*:—Dr. H. Hartridge and F. J. W. Roughton: The Kinetics of Hæmoglobin, II.—A. F. A. Young: The Thermionic and Photo-Electric Properties of the Electro-Positive Metals.—O. F. T. Roberts: The Theoretical Scattering of Smoke in a Turbulent Atmosphere.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. J. J. Findlay: Rhythm, Labour, and Child Development.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—A. Bachellery: The Electrification of the Midi Railway (Joint Meeting with the British Section of the Société des Ingénieurs Civils de France).

SOCIETY OF DYERS AND COLOURISTS (London Section) (at Dyers' Hall, Dowgate Hill, E.C.3), at 7.—A. D. Lang: Macbeth Artificial Daylight, and the Fade-ometer.

FRIDAY, NOVEMBER 23.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. Martin Duncan: Lantern Lecture.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—British Locomotive Practice and Performance.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. A. Tookey: Technical Arbitrations.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 17.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—G. Morris: The Prehistoric Survey of Selborne.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—S. H. Warren: The Cave-Paintings of Stone Age Man in Europe.

MONDAY, NOVEMBER 19.

KING'S COLLEGE, LONDON, at 5.30.—Prof. W. T. Gordon: Gem Minerals and their Uses in Art and Industry (Swiney Lectures). (Succeeding Lectures on November 21, 23, 26, 28, 30, December 3, 5, 7, 10, 12, and 14.)

TUESDAY, NOVEMBER 20.

UNIVERSITY COLLEGE, at 5.30.—Engr.-Capt. E. C. Smith: Epochs in the History of Marine Engineering.

WEDNESDAY, NOVEMBER 21.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. C. W. Saleeby: Sunlight and Disease.

UNIVERSITY COLLEGE, at 5.30.—A. Jenkinson: Handwriting and Early Printing.

THURSDAY, NOVEMBER 22.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.15.—Dr. J. W. Heslop Harrison: Problems of Variation. (Succeeding Lecture on November 23.)

LONDON SCHOOL OF ECONOMICS, at 5.30.—F. S. Marvin: Great Britain and Europe (League of Nations Union Lecture).

FRIDAY, NOVEMBER 23.

KING'S COLLEGE, LONDON, at 5.30.—C. E. M. Joad: The Philosophical Background of Music and Poetry: (1) The Function of Art.

ROYAL SOCIETY OF ARTS, at 8.—Major H. Barnes: Hygiene and Architecture: Remedial Hygiene—Health and the Hospital (Chadwick Lecture).

SATURDAY, NOVEMBER 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss E. Goodyear: The Romance of the Highways.

NATURE

SATURDAY, NOVEMBER 24, 1923.

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The Development of Cotton-growing in the British Empire.[1]

IN the years before the War, the exportable surplus of cotton from the United States was well over 4000 millions of pounds, or 8 millions of bales of 500 lb. each. At the present time it is only about $4\frac{1}{2}$ millions of bales (in very approximate figures), and there does not seem much possibility of any increase. This is due to various causes, chief among which may be mentioned (1) the ravages of the cotton-boll weevil, which has now, after thirty years have passed since its first invasion, spread over the whole cotton-growing region of the Southern States; and (2) the fact that the United States are every year consuming more and more cotton for the supply of their own mills. The demand for cotton goods in America seems insatiable, and is one of the principal factors in bringing about the present unfortunate situation in the British cotton industry.

American cotton, the fibre (or staple) of which is from an inch to an inch and one-eighth in length, provides the enormous bulk of the supply for Lancashire, the mills of which are constructed to deal with cotton of this length, and cannot at a moment's notice be altered to suit any other kind. Nor is there any other kind available in sufficient quantity, to say nothing of the fact that the demand is for goods of the present quality, which could not be equalled by spinning a cotton of shorter staple. The confusion of the exchanges, the diminished purchasing power of continental nations, and the smaller demand from India, have all contributed to lower the demand for Lancashire fabrics, but can scarcely go much further in that direction; and the consumption in America is increasing. Any rise in the Old World demand would cause the shortage to be felt even more acutely than it is, and even at present it is a very serious matter, which is reflected in the very high price at which cotton stands. American middling (the standard of the market) is now (Nov. 8) at 19·28*d.* per lb., against an average of 6·46*d.* in 1914.

In these circumstances the increased production of cotton of staple approximately equal to middling American, and elsewhere than in the United States, has become an urgent necessity, if the greatest manufacturing industry of Great Britain—upon which it is estimated that ten millions of people are dependent—is not to fall upon very evil days, which may mean widespread unemployment and distress. Among the most obvious countries in which to set to work to remedy the matter are those comprised within the British Empire. Dependence upon them for the supply of raw cotton would also bring other advantages in its

[1] Empire Cotton Growing Corporation. Report of the Administrative Council. Presented at the second annual general meeting on October 10.

train—it would give a fillip to colonial development, it would reduce the payments to be made to the United States, and would save paying in depreciated currency. Already for twenty years the British Cotton Growing Association has been devoting much money and effort to this object, and with considerable success—to such an extent, indeed, that the first and most difficult corner has been turned in several of the colonies, where cotton is now established among the possible crops that may be grown for profit. For some time, however, it has been felt that still greater and more widely organised effort is needed, and with this object in view there has been formed the Empire Cotton Growing Corporation, the sources of the funds of which are a capital grant from Government and a compulsory levy of *6d.* upon every 500 lb. of cotton purchased by spinners. The second annual meeting has just been held, under the presidency of Lord Derby.

Our thoughts turn naturally and first of all to India, as the second largest producer of cotton in the world. At present, however, that country counts for little so far as Lancashire is concerned, though producing every year some 4½-5 million bales. Only 243,000 were sent to Great Britain in the year ending July 31 last, and only 107,000 were consumed. The bulk of the cotton, which is mostly of short staple and poor quality, is used in Indian mills, or exported to Japan, and to a less degree to the continent of Europe. The locally made cloth, though somewhat coarse in texture, is of excellent wearing quality, and satisfies at a moderate cost a great part of the local demand.

As there seems to be small chance of growing in India within a short time large quantities of the longer-stapled cotton which Lancashire needs, attention must be directed to Africa and Australia. The Asiatic portions of the Empire outside India are in general too wet for the successful cultivation of cotton upon the large scale, whilst the West Indies have already devoted much of their small available area to the production of Sea Island cotton, which has the longest and finest fibre of all. The market for this cotton is but a small one, and the few thousand bales which are exported from the West Indies supply practically all of its requirements.

By far the largest producer in Africa, and one of the most important in the world, on account of the fine quality and long staple of its cotton, is Egypt. Recent political changes, however, have excluded this country from the Empire, and it remains to be seen whether the effect of these may not be to make even worse the present difficult situation in cotton, by involving a falling-off in production, or a deterioration of the quality or length of staple.

In the rest of Africa the cultivation of cotton for export is still comparatively new, and that it exists at all is due to the work of the British Cotton Growing Association referred to above. Cotton-growing is now becoming of serious importance in the Sudan, in Uganda, and in Nigeria, while South Africa, Tanganyika, and other parts are making a good start. In all of them the export is increasing, and in Uganda it now reaches the respectable figure of about 90,000 bales annually (Lancashire now uses about 3 million bales of American cotton). The important fact is that the corner has been turned, and many people know that cotton can be cultivated to a profit in these regions, so that others will probably follow their example, and the export will increase. After having cultivated cotton for some years, people will be less likely to abandon it in the event of an unpropitious year, and the cultivation will be much more likely to be permanent.

While in tropical Africa the crop is mainly in the hands of the natives of the country, there appears to be a good prospect that portions of South Africa may offer good prospects and suitable conditions for cultivation by people of European descent.

Finally, we must consider Australia, where the cultivation of cotton is carried on by white men. Queensland and New South Wales are proving to be excellently well suited to the crop, and the principal thing that remains to be seen is whether the policy of a "white Australia" will allow of enough labour for important extension. If this extension can take place, Australia should become a factor of serious importance upon the cotton markets.

The import into Lancashire of Empire-grown cotton is as yet but small compared to the enormous quantities arriving from the American continent, north and south, but it is by no means unimportant, and there is every reason to hope that at no very distant period, under the fostering care of the Empire Cotton Growing Corporation, it may reach a million bales, or about a quarter of the consumption.

The work of the Corporation is at present in its initial stages. A separate committee is at work in India upon somewhat similar lines, aided by a cess of 4 annas on every bale of cotton used or exported. Specialists have been appointed to report on prospects and conditions in South Africa and elsewhere, and some of the African colonies are being helped by grants made to their agricultural departments for the express purpose of work upon cotton under the supervision of specialists appointed by the Corporation. Research is under way in St. Vincent, grants-in-aid are being made to institutions conducting research in Great Britain, and the question of establishing a research station in some cotton-growing country is under consideration. A number of studentships have been given, and the

men are being trained at the Imperial College of Tropical Agriculture, Trinidad, at Cambridge, and elsewhere, while some of those who have finished their training are being employed in the African and other colonies in supervising work with cotton under the charge of the specialists. A large illustrative exhibit is being prepared for the British Empire Exhibition at Wembley next year, a journal is being started under the editorship of Dr. J. C. Willis, F.R.S., and in many other ways the Corporation is settling to work at the gigantic problem before it.

It is clear that the activities of the Corporation will be likely to result in a considerable demand for men of the right kind, and at present there is difficulty in finding these. Highly trained agriculturists with knowledge of cotton-growing are difficult to discover, nor does the supply of young men who have taken a degree in pure science and followed this with some agricultural training meet the demand which at present exists in this new branch of scientific tropical agriculture.

The Forests of India.

The Forests of India. By Prof. E. P. Stebbing. In 3 vols. Vol. 1. Pp. xv + 548 + 27 plates. Vol. 2: *The Development of the Indian Forest Service.* Pp. xii + 633 + 36 plates. (London: John Lane, The Bodley Head, Ltd., 1922–1923.) 42*s.* net each.

PROF. STEBBING'S work deals with the history of forest conservancy in India from the time of the recent Post-Tertiary period to the present time. In volume i. he gives the history from the earliest date to the year 1864; in volume ii. from 1864 to 1900; the period 1900 to the present time is reserved for volume iii., not yet published. The matter assigned to volume i. is further divided into four sub-periods, the last of which comprises the years 1857–1863. Volume ii. is divided into two sub-periods, the first of which comprises the years 1864–1870. The author then, in a way, throws these two sub-periods together again and says that the fourteen years, 1857–1870, witnessed the true foundation of forest conservancy in the different provinces of the Indian Empire.

In the early part of volume i. the general features of India are indicated; its geography, geological features, climate, the distribution and the general character of the forests at the time of the arrival of the English in India. Fire, shifting cultivation, and careless utilisation had considerably reduced the area of the forests and changed their composition, a process which went on, practically unchecked, until the middle of the nineteenth century. The East India Company periodically directed attention to the mischief and urged the adoption of measures to stop it, but the Government of the country did not take action until the Bombay Dockyards ran short of timber for naval construction. A timber agency was set up early in the nineteenth century, but abolished again in 1823, in consequence of its arbitrary proceedings. For some time after this, any small progress was due more to the exertions of active individuals in the services than to the Government as a whole. Among these Mr. Conolly, the Collector of Malabar, stands out. He started the well-known Nilambur teak plantation in 1843. This was so successful that it proved the possibility of making forest conservancy in India financially profitable. Other examples are the activity of Dr. Gibson in Bombay, Dr. Cleghorn in Mysore and Madras, and Dr. Wallich, Capt. Tremenheere, and Mr. Colvin in Burma. These officers and many others did, no doubt, a great deal of good, but their efforts were disjointed; however, they created a feeling that action on a definite plan was wanted.

In 1855 Lord Dalhousie took up the matter. His first step was to appoint Dr. Brandis superintendent of the Pegu teak forests. The latter joined in Burma in 1856, and, supported by Major Phayre, the Commissioner of Pegu, during the following six years he saved the Lower Burma teak forest from the threatening destruction. Soon after the effect of the Mutiny had somewhat subsided, the Government of India began to occupy itself with the question of more effective forest conservancy generally. Dr. Cleghorn was called up from Madras in 1861 to advise about forest conservancy in Upper India, and a year later Dr. Brandis (it is said on Dr. Cleghorn's suggestion) was brought up from Burma to join in the work. In 1864 the Government, with the approval of the Secretary of State for India, established a regular Forest Department with Dr. Brandis as first Inspector-General of Forests.

Dr. Brandis was a man of science, of great knowledge and endowed with a remarkable working power. He had recognised in Burma that lasting benefit could not be achieved without placing the forest business on a legal basis, and he succeeded in having a special Forest Act passed in 1865. That Act had, however, a great defect: it did not provide a legal inquiry and regulation of rights of third persons in the areas proposed for permanent State forests. Hence, in 1868, Brandis proposed a revised Act, and this proposal led to a protracted discussion which did not end until 1878, when the Indian Forest Act passed the Legislative Council. It is still in force with some minor additions, but special Acts were passed for Burma and Madras based on the same principles as the Indian Act but providing for some provincial differences. All these Acts give power to inquire into, regulate, and, if necessary, commute the rights of third persons in areas declared or proposed as Reserved State Forests; to

establish village forests to be managed for the benefit of local communities; to protect the forests generally as well as their produce; to organise the administration and working of the forests, and allied matters.

Brandis, on taking charge of the Department, found the existing staff sadly deficient. There were some excellent administrators in it, mostly military officers, including medical men, but there was little knowledge of systematic management with the object of securing a sustained yield in the future. His plan, from the outset, was to obtain a sufficient number of scientifically trained officers, to start the treatment of the forests on the right lines, and to utilise them for the training of Indians to fill the posts of rangers and foresters, promotion to the superior grade being open to those who were fit for it. There being, at that time, no opportunity in India or in Britain to acquire a high standard of scientific forestry, Brandis proposed to send young Englishmen for the necessary instruction to the Continent, Germany and France, where systematic forest management had been practised for more than a century. In the meantime the service in the several provinces of India was organised as well as possible. The formation of Reserved State Forests was commenced, the methods of exploitation improved, the general protection of the forests effected, and especially fire protection commenced, the latter being inaugurated successfully by Capt. Pearson in the Central Provinces. Shifting cultivation in the valuable parts of the forests was restricted or at any rate regulated, taungya teak cultivation in connexion with shifting cultivation introduced in Burma, whence it has spread to other parts of India and produced highly important results.

From the very beginning Brandis drew up preliminary working plans for the forests which he visited, a practice which he continued up to the time of his leaving India. Other officers followed his example, but, as the administration had to a considerable extent been provincialised, there was no security for the plans being executed. When Dr. Schlich took over the Inspector-Generalship from Dr. Brandis in 1881, he recognised that, to secure a continuous yield from the forests in the future, steps must be taken to push on the preparation of working plans based on the principle of a sustained yield, and especially to secure the execution of the plans when once sanctioned by Government. He obtained the sanction of the Government of India and of the Secretary of State for India for the establishment of a Working Plans Branch under the supervision of the Inspector-General, assisted by an Assistant Inspector-General. The plans were prepared under the direction of the local governments, but the Inspector-General had to be consulted as to the lines on which they were to be drawn up, and, when once approved by the local government, he was kept informed of the progress of execution, so that he could direct the attention of the local government to any deviation from the sanctioned provisions. It was foreseen at the time that, as the operations of the Department developed, the control would have to be handed over to the local authorities, and this has now actually been done. The establishment of this branch was, as Prof. Stebbing states in volume ii., considered "an epoch-making move forward." As a result nearly all important forests are now worked under the provisions of well-prepared plans; moreover, the yield capacity of the forests became known and can safely be worked up to, while a great store of valuable information bearing on the silviculture and general management of the forests was put on record. It is not too much to say that the establishment of the Working Plan Branch was a forerunner of the Forest Research Institute at Dehra Dun, which, however, did not come until twenty-two years afterwards.

Prof. Stebbing deals in detail with the development of the education of the staff, both superior and subordinate. The recruits for the former continued to be educated on the Continent until 1886, but in 1885 the first School of Forestry in Britain was opened at Cooper's Hill. The organisation of this was entrusted to Sir William Schlich. It remained at Cooper's Hill until 1905, when it was transferred to the University of Oxford. As soon as a sufficient number of duly qualified teachers of forestry had been secured, the establishment of an Indian School of Forestry at Dehra Dun was effected, in 1878, for the training of the ranger class of officers. It was gradually improved, so that by 1900 it had been brought up to a standard which made it possible to undertake the instruction of the recruits of the provincial part of the controlling staff. Indeed, it is likely that soon the whole of the superior staff will be educated at Dehra Dun.

Prof. Stebbing says in the preface to volume ii. that the fourteen years, 1857 to 1870, witnessed the true foundation of forest conservancy in the different provinces of the Indian Empire, and that the work which was undertaken during the period 1871–1900 was the natural corollary and outcome of the lines laid down between 1857 and 1870. This is, in our opinion, an exaggerated view, because, as has been indicated above, several of the most important measures which secured the success of the whole undertaking were conceived and introduced during the period 1870–1900. Not only was all the spade-work done during the latter period, but also rational forest conservancy became an established fact. Not far short of 100,000 square miles had definitely become permanent State forests; the greater part of these were worked according to the

provisions of well-prepared working plans; more than half the area was protected against the annually recurring forest fires; most of these areas had been surveyed and mapped; the education of the staff had reached a high standard; and, last but not least, a remarkable amount of research had been accomplished during the period, as evidenced by such works as Brandis's "Forest Flora of North-West and Central India," a book of such excellence that the author was forthwith elected a fellow of the Royal Society; Gamble's "Manual of Indian Timbers" and his great work on Indian "Bamboos"; and Baden Powell's "Forest Law." Nor should it be forgotten that the greater part of the material with which Brandis dealt in that monumental work entitled "Indian Trees" was collected during the second half of last century, although the book was not published until 1906. It would lead too far to mention works on forestry proper. The *Indian Forester* was started by Sir William Schlich in 1875. Prof. Stebbing calls it a mine of information from a perusal of which a great deal is to be learned. A great quantity of observations on the silviculture of Indian trees is incorporated in numerous reports, and it has only lately been collected and made available to foresters generally. Unfortunately, the establishment of the Forest Research Institute at Dehra Dun was too long delayed, but what part of the Empire has not sinned in the same manner?

Twenty chapters of volume i. and ten chapters of volume ii. are devoted to a description of the progress in forest conservancy in the several provinces of India. The last chapter of volume ii. contains an appreciation of three Inspectors-General of Forestry. Prof. Stebbing gives the text of resolutions by the Government of India acknowledging the services of Sir Dietrich Brandis and of Mr. Ribbentrop, and remarks that no such resolution was passed acknowledging the services of Sir William Schlich. The latter statement is not correct, as a resolution acknowledging the valuable and distinguished services of the last-mentioned was passed by the Governor-General in Council on February 7 and published in the *Gazette of India* of February 9, 1889.

Apart from some passages which might be questioned by past or present members of the Indian Forest Service, Prof. Stebbing has produced a very full account of the development of Indian forest conservancy up to the year 1900. It is based on the study of a vast number of works and writings, among which Ribbentrop's "Forestry in British India" takes a prominent place. A rainfall map is attached to volume i., and a general map of India to volume ii. Sixty-three artistic illustrations are inserted, and they serve as pleasing resting-places during the perusal of the book.

Cambridge Biographies.

Alumni Cantabrigienses: a Biographical List of all known Students, Graduates, and Holders of Office at the University of Cambridge, from the Earliest Times to 1900. Compiled by Dr. John Venn and J. A. Venn. Part 1: From the Earliest Times to 1751. Vol. 2: Dabbs—Juxton. Pp. v+492. (Cambridge: at the University Press, 1922.) 7*l.* 10*s.* net.

THE second volume of this monument of industry and antiquarian research carries the list of members of Cambridge University prior to 1751 down to the name of Juxton. The first four volumes, covering the whole of the early period, are to be published by the end of next year, and the editors now ask for additions and corrections to the data already published.

In the present volume, among men of science of repute we note the names of De Moivre, a Protestant refugee from France, and Sir Kenelm Digby, one of the original members of the Royal Society, who was at one time banished to France; Thomas Gale, regius professor of Greek and first secretary to the Royal Society; J. Flamsteed, first Astronomer Royal, and Jeremiah Horrox, who predicted and observed the transit of Venus in 1639; Gilbert, the physicist, and William Harvey and Glisson among many distinguished members of the medical profession. Of those who combined eminence in two distinct branches of science may be mentioned Dacres, who was professor of geometry and censor of the Royal College of Physicians. Of those known more widely in a different sphere we note John Dryden, who was discommuned for contumacy to the Vice-Master of Trinity; the Duke of Northumberland, Chancellor to the University in 1551, who was executed on Tower Hill; N. Eaton, first master at the school in Cambridge, Mass., which afterwards became Harvard College—and John Harvard himself. Orlando Gibbons, Thomas Gray, George Herbert, Robert Herrick, and Ben Jonson bear witness to Cambridge's continued love of the muses; the name of Judge Jeffreys strikes another note, as also do the names of Erasmus, Thomas Gresham, founder of the Royal Exchange, and Thomas Hobbes.

Amongst distinguished Cambridge families we find the Darwins and the Howards. The latter in their history bear witness to the religious disputes which have in the past left their stamp on Cambridge as on England. Martyrs on both sides were educated there. The position of Cambridge in the Civil War is suggested by the names of Fairfax, Fleetwood, Hesilrig, and Hollis, though the Earl of Montrose represents the other side. Among the points of human rather than of historical interest we may note the sentence of transportation on Henry Justice for stealing books from the University Library, and the history of Adam Elliot, a slave to

Moorish pirates. Francis Dawes, who hanged himself with the chapel bell-rope, must have had a grim sense of humour. Lastly, the modern touch giving the sense of continuity in the history of Cambridge is supplied by William Hawteyne, who went out as an army chaplain in Flanders and Germany.

The *Quest* Expedition and its Lessons.

Shackleton's Last Voyage: the Story of the "Quest." By Comdr. Frank Wild. From the Official Journal and Private Diary kept by Dr. A. H. Macklin. Pp. xvi + 372 + 100 plates. (London, New York, Toronto and Melbourne: Cassell and Co. Ltd., 1923.) 30*s.* net.

CLOSE upon the heels of the excellent "Life of Sir Ernest Shackleton," by Dr. H. R. Mill, comes the story of his last voyage. It is told by his old comrade in adventure, who took part in all the expeditions with which Shackleton was connected, and whose experience of Antarctic life was even greater than Shackleton's. Commander Wild is assisted in his literary labour by a member of the expedition who seems to have been invaluable at every turn, Dr. A. H. Macklin.

The tale is told in a plain, straightforward manner which reflects the character of the writers, who ask neither for eulogy nor for sympathy, although both will be readily forthcoming. Of the success they hoped for there was but little, of the bitterness of thwarted plans there was much, but there is small mention of either. The events of the voyage are duly chronicled, and comment is usually reduced to the minimum. The main features of these events are already well known through the medium of the daily press, but the book adds to them so much in the way of personal detail, and the pros and cons of the decisions which were made, that we recognise at once the inadequacy of a press narrative.

The expedition was unfortunate almost throughout, and the story resolves itself into a tale of misfortunes endured or overcome, many but not all of which were unavoidable. The crowning misfortune, the loss of its leader before the expedition had even reached its cruising ground, would have wrecked the future of most expeditions, and it is this which absorbs one's interest and overshadows the other incidents to a great extent. Every reader, and especially those with Antarctic experience, will admire the spirit of Wild's decision to "carry on" after the death of the leader; indeed, in the circumstances as given in this book, none would have blamed him had he turned back.

It is the duty of every leader of an expedition to write its narrative, the tale of the things done; but as he writes it we suspect that he writes a second one in his own mind, the tale of the things left undone and the things he did unwisely, and there can be no doubt that the one which does not reach the printer is the more valuable of the two. It is in no unfriendly spirit, and with the greatest admiration for all the actors in the story, that we propose to examine some of the causes of misfortune, causes which must be writ large in Commander Wild's own mind as things he would avoid next time. It is the business of those interested in polar exploration to extract the lessons of the past as well as to applaud its successes.

With so popular a leader, so varied a programme, and so small a ship, it was perhaps inevitable that the expedition should have become the prey of the sensation-monger reporter before it started. Such a fate should rank perhaps as a nuisance rather than as a misfortune, but it was scarcely fair either to the leader, harassed with the thousand details of preparation, or to the members, most of whom had their polar spurs yet to win, to find the press following every movement, publishing every plan, and "featuring" every detail down to the ship's cat.

Beside such a small matter, the enforced change of plans at a late date was a very real misfortune. The fundamental character of this change, for which but a few months was available, is perhaps not appreciated by the general reader, to whom the Arctic and the Antarctic are merely opposite poles of cold and unpleasantness. The change was really from a short North Atlantic voyage followed by sledging exploration in the Beaufort Sea—essentially a land expedition, in fact—to an oceanographical cruise in the stormiest seas of the world, essentially a ship expedition. We deplore the change for other reasons, for we believe that a leader with the qualities of Shackleton, and followed by the men he had selected, would have made great discoveries in the blank spaces of the Beaufort Sea. Indeed, only the most urgent circumstances could have prevailed on the leader to make such a change, circumstances not at all covered by the phrase, "as it was too late to catch the Arctic open season the northern expedition was cancelled."

Even so, we think that success would have been somehow achieved were it not that the element of hurry now came doubly into the preparations, an element which must have been responsible for the totally inadequate survey of the *Quest's* boilers and engines, the defects in which crippled the expedition from the moment it left England. It is sad to read, for example, that only after infinite delay and expense, enforcing vital changes in the plans—in fact, only after reaching South Georgia—was it found on consulting the ship's record that the boilers were thirty-one years old, and Commander Wild marks his surprise and chagrin by

printing the fact in italics. While these fundamentals were somehow overlooked, the ship was equipped with an array of special fittings such as no former polar ship could boast—enclosed bridge, clear-view screens, gyroscopic compasses, double set of wireless, etc.—all very helpful, no doubt, but one can imagine the remarks of the ship's officers when, though surrounded by these devices, they had to nurse a leaky boiler and a crankshaft out of the true.

The initial cost of the *Quest*, a small wooden vessel of 125 tons, was 11,000*l.*, and we imagine that before she returned at least as much again must have been spent upon her. Even allowing for the fact that she was bought when the shipping market was at its peak, it is clear that oceanographical or polar expeditions are ruinously expensive, nor can former expeditions present much more satisfactory balance-sheets.

The *Discovery* was designed and built in 1900 for Antarctic exploration, and cost more than 50,000*l.*; she was sold afterwards for a fraction of that sum. She is now being reconditioned at a cost comparable with her first cost, to continue, after twenty years, the work for which she was originally designed. During that period Scott, Shackleton, and Mawson, to mention only the chief leaders, have wanted her and had to put up either with inferior ships or have lost heavily over buying and selling. Meanwhile, the only ship ever built specially for the Antarctic has been sealing or dry-rotting in dock. Manifestly we are here touching upon what might almost be called a scandal, but it is one for which no one in particular is responsible, unless it be the companies who make large profits by selling and buying exploring ships. The real scandal is that polar exploration is so little organised, the efforts are so spasmodic and independent, that it was no one's business to keep the *Discovery* after her first voyage and charter or lend her when she was again required.

That, we believe, is the real lesson to be learnt from the story of the *Quest*; and it is a lesson, not for the Shackletons and Wilds of the future, but for us stay-at-homes who urge them on, who even subscribe towards their ventures, but take no steps to secure continuity from one expedition to the next.

The book is well illustrated, but is extraordinarily deficient in good maps. It is time that publishers, if not their authors, realised that adequate maps are essential to such books and improve their selling prospects. Perhaps the most valuable part of the book is the medical appendix written by Dr. Macklin, in which he gives the most up-to-date summary of medical conditions on a polar expedition, with advice drawn from his own experience on such subjects as scurvy, frost-bites, and sledging rations.

F. DEBENHAM.

Metallurgical Furnaces.

The Flow of Gases in Furnaces. By Prof. W.-E. Groume-Grjimailo. Translated from Russian into French by Leon Dlougatch and A. Rothstein. Translated from the French by A. D. Williams. With an Appendix upon the Design of Open-Hearth Furnaces. Pp. xxi+399. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 27*s.* 6*d.* net.

THE construction of furnaces for metallurgical purposes has been guided in general by rule of thumb, practical experience having shown a particular furnace to work well, and a similar design being adopted in new plant, without any established principles to serve as a guide to the designer. In 1911 there appeared an important work in Russian, by Prof. Groume-Grjimailo, in which an attempt was made to place the subject on a scientific basis. Being translated into French in 1914, and introduced to the French public by Prof. Le Chatelier, this novel treatise attracted much attention, and it has now been made available, in an extended form, to the English-speaking world. It should be studied with care wherever furnaces are used. The loss of heat in most metallurgical furnaces is large, and economies in this direction are of great importance in the improvement of industry, especially in view of the great increase in the cost of fuel.

The guiding principle of the work is recognition of the fact that the densities of hot and cold gases differ so much that a mass of flame passing through a furnace may be treated as if it were a light fluid, floating on the heavier mass of gas at a lower temperature beneath it. It is then possible to apply the laws of hydromechanics to the case of furnaces. For purposes of study and demonstration, sectional models of the furnaces are made, enclosed between sheets of plate glass, water being introduced, and a light liquid, such as kerosene, coloured for distinctness, being then admitted through the gas ports. It is then easy to see how the light liquid, representing flame, distributes itself through the furnace. The difference between the efficiencies of updraught and downdraught kilns is at once made evident by this method, and the use of such models is becoming common. Many examples are given by the author of furnaces which were unsatisfactory in their working, but became efficient on being reconstructed in accordance with these principles. The consequences are worked out quantitatively, and formulæ are arrived at which may be used by the furnace designer.

It may be suggested, however, that the author scarcely takes sufficient account of radiation as a means of supplying heat to the objects in the furnace. The translator has added greatly to the value of the work

by supplying long appendices on the design of Siemens furnaces, hot-blast stoves, and boiler settings, in which the author's principles are applied to a large number of concrete cases, with an abundance of numerical data. Tables of thermal data and curves giving the heat capacity and calorific intensity of some of the most typical gaseous and liquid fuels complete a book which should exert a great influence. C. H. D.

Our Bookshelf.

Periodicals of Medicine and the Allied Sciences in British Libraries. By Prof. R. T. Leiper; with the collaboration of H. M. Williams and G. Z. L. Le Bas. Pp. vi+193. (London: British Medical Association, n.d.) 10*s.* 6*d.*

THE provision of Union Lists of Periodicals filed in our University centres is now recognised to be an indispensable aid to research. Such Lists should be authoritative. They should be issued at frequent intervals and on a uniform basis of compilation. Their type should be kept standing with the view of reducing the labours of their compilers and the cost of successive editions to their buyers. Something has already been accomplished in this direction; but the ground is not yet adequately covered.

Union Lists of Periodicals, however, representing specific branches of knowledge, stand upon a less secure footing. Dr. Leiper's "Periodicals of Medicine and the Allied Sciences in British Libraries" illustrates the difficulties which beset the path of the untrained compiler of these sectional lists in the absence of a printed National Union List covering the whole range of periodical literature. Judged by the "standards which guide professional librarians" (we are quoting from Dr. Leiper's preface), the work before us cannot be regarded as satisfactory, in more than one respect. Wales, for example, is not represented in the List; the Scottish libraries are not represented by the Advocates' Library in Edinburgh, or the London libraries by the Library of the Patent Office. These are serious omissions. We do not, however, propose to justify our criticism further, for to some extent the defects in the List are admitted in the preface. We prefer to meet Dr. Leiper on his own ground. The compiler and his collaborators have grappled manfully with a very difficult task, and have succeeded in producing a work which will be serviceable to students in the field of medical research, provided that they do not lean too heavily upon its bibliographical sufficiency and accuracy. Further, we trust that its publication will serve to promote a higher co-ordination of work among professional librarians—in respect of which, as Dr. Leiper suggests, there is still great room for improvement.

Nickel Ores. By W. G. Rumbold. (Imperial Institute: Monographs on Mineral Resources, with special reference to the British Empire.) Pp. ix+81. (London: John Murray, 1923.) 5*s.* net.

THIS little volume is written in the same way and upon the same lines as its predecessors in the series of Imperial Institute monographs on mineral resources; that is to say, it commences with a brief account of the mode of occurrence and the character of nickel ores, the metallurgy of nickel, and the uses to which this metal is put industrially, followed by a description of the occurrences of nickel ores within the British Empire, and finally of the foreign sources of supply of this metal. The task is in so far rendered an easy one because the author had at hand the well-known report of the Royal Ontario Nickel Commission published in 1917, in which the whole subject is most exhaustively dealt with. This great report is, however, too voluminous for the ordinary seeker after general information, and the present monograph fulfils a useful object in presenting the subject matter in a more convenient and more readily accessible form. It should be added that Mr. Rumbold has done his work very well. The section on the applications of nickel, although brief, is tolerably comprehensive, although more attention might perhaps have been given to nickel-plating, which is becoming of very great industrial importance. In other respects the author appears to have covered the ground very thoroughly;. he scarcely does full justice to the important part that Norway has played in nickel production in the past, and, to judge by the bibliography attached, does not seem to have consulted the tolerably extensive Norwegian literature on the subject. Upon the whole, it may fairly be said that the work carries out very well the intention of the series, namely, "to give a general account of the occurrences and commercial utilisation of the more important minerals."

Proceedings of the Aristotelian Society. New Series, Vol. 23: Containing the Papers read before the Society during the Forty-fourth Session, 1922–1923. Pp. ii+289. (London: Williams and Norgate, 1923.) 25*s.* net.

PHILOSOPHY takes account of the meaning of things. At the present time, it is partly occupied with new conceptions of the structure of the material universe, or matter, in terms of theoretical physics. Among the papers in the current issue of the Proceedings of the Aristotelian Society—mainly devoted to dialectical discussions of classical themes or the re-statement of old problems—attention may be directed to three. The Rev. Leslie Walker's "New Theory of Matter" —new, in the sense of its being pre-Aristotelian—is (he says) an attempt to deduce from relatively simple first principles the laws of co-existence and sequence which have been found experimentally to hold good between observed changes in the sphere both of quantity and quality. He finds that the essence of a thing lies in the fundamental structure or ratio—*forma substantialis*—which holds between the potentialities themselves.

Dr. E. S. Russell's "Psychobiology" is a monadistic conception—opposed to the mechanistic or vitalistic view—in which living things appear to show a persistent and enduring individuality of action unparalleled in the inorganic realm: structure and function, he maintains, must be treated as one and inseparable.

Prof. Sellars, in a thoughtful paper on the "Double-Knowledge Approach to the Mind-Body Problem," demands a deepening of our metaphysical categories: there exists, indeed, in Nature a level of causality,

of self-determination, which does not easily fit into the traditional interpretation of Nature.

Entomology: with Special Reference to its Ecological Aspects. By Prof. J. W. Folsom. Third revised edition. Pp. vii+502. (London: John Murray, 1923.) 21*s.* net.

PROF. FOLSOM'S well-known text-book gives a clear and concise account of the various aspects of entomology, and is written with the object of meeting the growing demand for a biological treatment of the subject. The present (third) edition includes a considerable amount of new letterpress, with the addition of an opportune chapter on insect ecology, and some 250 titles have been added to the bibliography. Considering the limited size of the book (500 pp.), the author has been remarkably successful in dealing with his subject in a comprehensive manner. An elementary treatment is, of course, only possible within this compass. Entomology, like other branches of science, has made such rapid strides during the last twelve years or so, that it is almost impossible to compress a really adequate work into less than 800 or 900 closely printed pages. There is a great need at the present time for a more advanced book, since works of an elementary nature are tolerably numerous. Among the latter, Prof. Folsom's book is undoubtably one of the best. The author's admirably terse and lucid style is of great value to the beginner, while the up-to-date bibliography, that is appended at the end, serves as a guide to the sources where fuller information is obtainable.

How to Build Amateur Valve Stations. By P. R. Coursey. Pp. 70. (London: The Wireless Press, Ltd.; New York: The Wireless Press, Inc., 1923.) 1*s.* 6*d.* net.

WE can recommend this book to all who want to take advantage of the latest developments of radio telephony. The author is equally at home on the scientific as well as on the practical side of the art, and experts attach weight to his views.

The very simple sets described can be trusted to work admirably on days when the electrical condition of the atmosphere is not very disturbed. A set for use in Great Britain should have a tuning range from 300 up to 2700 metres. This would include the Eiffel Tower time signals, which are usually made on a wave length of 2600 metres, the French "radiola" concerts, which are sent on a wave-length of 1500 metres, the Hague concerts on 1050 metres, the French concerts from "l'École des Postes et Télégraphes" on 450 metres, and the British concerts broadcasted on wave-lengths varying between 350 and 425 metres. Careful and accurate descriptions are given of the components of valve receiving sets, the diagrams can be read at a glance, and the many useful practical hints will be welcomed by amateurs.

Labyrinth and Equilibrium. By Prof. S. S. Maxwell. (Monographs on Experimental Biology.) Pp. 163. (Philadelphia and London: J. B. Lippincott Co., 1923.) 10*s.* 6*d.* net.

MANY different views have been held as to the respective functions of the ampullæ, otoliths, and other constituent parts of the internal ear, and any fresh evidence on the subject must be welcome to physiologists. Prof. Maxwell seems to have attained a high degree of accuracy in his experimental methods, especially in dealing with the otoliths. He shows, for example, that compensatory movements to rotations around the longitudinal and transverse axes continue so long as the otolith of the recessus utriculi remains uninjured. He further shows, in the case of the ray, by mechanical pressure upon the otolith in different directions, that it is the displacement of the otolith and not its own pressure which is the actual stimulus, and that it is the direction of the displacement which determines the direction of the compensatory movement. Unfortunately, his experiments leave us completely in the dark as to the reason for the existence of the three semicircular canals and their highly characteristic orientation.

Radioactivity and the Latest Developments in the Study of the Chemical Elements. By Prof. K. Fajans. Translated from the fourth German edition by T. S. Wheeler and W. G. King. Pp. xvi+138. (London: Methuen and Co., Ltd., 1923.) 8*s.* 6*d.* net.

PROF. FAJAN'S book is particularly addressed to chemists, and it gives in a very readable form the important developments in the study of radioactivity, isotopes, atomic numbers, and the structure of the atom which have been made in recent years. The subjects are dealt with briefly, but in a very authoritative manner, and chemical students will find the book of great interest and value. There are references to the literature and an index. The book is well printed and illustrated. One might have wished for a little more detail of experimental methods (*e.g.* in connexion with Moseley's work, which is not described, whereas Aston's apparatus is figured and explained), but in the limits of his space the author has generally made a wise choice of material. The numerical constants in the tables of radioactive series (pp. 21-23) in some cases differ slightly from those adopted in the Report of the International Commission on the Elements (1923).

Geometry Practical and Theoretical, Pari Passu. By V. Le Neve Foster. In 3 vols. Vol. 3: Solid Geometry. (Bell's Mathematical Series for Schools and Colleges.) Pp. xiv+423-585+viii. (London: G. Bell and Sons, Ltd., 1922.) 3*s.* 6*d.*

THIS is the third part of a work of which we have already noticed the first and second parts (NATURE, June 10, 1922, vol. 109, p. 737). Mr. Foster continues to combine the theoretical with the practical, and added interest is obtained by historical references. The scope of the book is indicated by the fact that it deals with parallelepipeds and tetrahedra, lines and planes, gradients, regular solids, and the sphere. There are chapters on the mensuration of prisms, pyramids, and spheres, as well as on solid angles and Euler's theorem. A concluding chapter on the earth is particularly useful and instructive.

We like this volume very much, and think it makes a most useful and pleasant addition to the available elementary literature on solid geometry. S. B.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Gorilla's Foot.

SIR RAY LANKESTER, in his recent book, "Great and Small Things," makes the following statement in the chapter on "The Gorilla of Sloane Street":

"An entirely erroneous figure of the gorilla's foot is given by Mr. Akeley in the *World's Work* of October 1922. He gives valuable observations on the habits of the gorillas made when hunting this animal in the neighbourhood of Lake Kivu, in Central Africa. He made casts of the head, hands, and feet of specimens killed by him. But the cast of the foot is (as shown in a photograph) strangely distorted, and made to present a false resemblance to the foot of man. Since Mr. Akeley was securing specimens of gorilla for the American Museum of Natural History in New York, it is well that his mistake about the gorilla's foot should be corrected at once."

I have examined the cast of the foot made by Mr. Akeley, who states that the cast was made in the relaxed position after rigor mortis had passed away. There has been no retouching or alteration, and the photographs published in *World's Work* give a very fair representation of it. The foot of Mr. Akeley's old male gorilla undeniably differs in many details from that of John, the young "Gorilla of Sloane Street," and still more from that of an infant gorilla formerly in the New York Zoological Park.

Dr. D. J. Morton, an orthopædist, has recently published an important article on the evolution of the human foot in the *American Journal of Physical Anthropology* (Oct.-Dec. 1922), in which the structural contrasts in the skeletons of infant and adult gorilla feet are shown to be connected with the differences in function and in body weight. Mr. Akeley's old male gorilla foot is amazingly manlike in general appearance; his female gorilla foot shows a distinct peroneus tertius muscle. No doubt the great toe could be more or less abducted from the other digits, but the cast represents the foot as it was in the relaxed condition. There is no evidence from the cast that the foot is "strangely distorted, and made to present a false resemblance to the foot of man."

From a copy of this cast which is being sent to the British Museum (Natural History), English naturalists will have an opportunity of judging whether Sir Ray Lankester's criticisms are justified.

WILLIAM K. GREGORY.

American Museum of Natural History,
New York, September 21.

MY "criticisms" quoted by Dr. William K. Gregory refer to a text-figure published by Mr. Akeley in the *World's Work* of October 1922. As to whether this figure gives "a very fair representation" of the cast of the gorilla's foot made by Mr. Akeley, and what precisely Dr. Gregory means by "very fair," we shall be able to judge when the promised copy of the cast is received at the Natural History Museum. My own experience is that a photographic camera turned on to such an object as the cast of the foot of a dead gorilla will yield a misleading, or even a "distorted," picture if special skill has not been exercised in both the posing and the illumination of the photographed object, and also in the manipulation of the camera.

I should be greatly pleased were Mr. Akeley to demonstrate that the foot of the gorilla from Mount Mikeno is, as he supposes, unlike that of the other adult gorillas long known to naturalists, as well as unlike that of any known anthropoid.

FIG. 1.

Fig. 1 is reproduced photographically from that given by Mr. Akeley in the *World's Work* as representing a cast of the foot of a large gorilla, taken immediately after death. It is unlike any other published figure of a gorilla's foot. I place here beside it the figure of the plantar surface of the gorilla's foot (Fig. 2) as recorded by Mr. Pocock, of the Zoological Society of London. I accept this Fig. 2 as correct. It agrees with all other statements and illustrations prior to that of Mr. Akeley.

FIG. 2.

The explanation of this discrepancy which appears to me probable is that Mr. Akeley's cast of the foot of the gorilla—reproduced here as Fig. 1—has been accidentally distorted, so that the photograph is misleading. It is highly improbable that Fig. 1 corerctly represents the foot of a normal species or variety of gorilla.

Since writing the above, I have received by the courtesy of the publishers—Messrs. Heinemann—advanced sheets of Mr. Akeley's new book called "In Brightest Africa." My opinion that owing to some unfortunate mistake the cast itself of the gorilla's foot figured by Mr. Akeley is defective and distorted is favoured by the photograph, labelled "A Gorilla's Foot and Hand," which faces p. 230 of the new book. This photograph is not taken from a cast but from the actual foot and hand of a dead gorilla. It shows the plantar surface of the foot, and this differs very widely from the same region as shown in the cast under discussion, which is taken

from another specimen. In this new photograph the great toe is large and diverges from the other toes as in my Fig. 2 (here printed). But its terminal phalanx is flexed and the foot is so posed that the great digit projects over and in front of the bases of the other digits and is consequently foreshortened in the photograph. The shape of the plantar surface and that of the heel is *not* that shown in the photograph of Mr. Akeley's cast—but is that already familiar to those who have made a study of the gorilla's foot. It is a happy circumstance that Mr. Akeley presents his readers with conclusive evidence condemning his plaster cast of the gorilla's foot, side by side with the photograph of that misleading production (which faces p. 242). He could not deal more frankly and straightforwardly with the matter than this. E. RAY LANKESTER.

October 5.

Determination of the Temperature of the Upper Atmosphere by Meteor Observations.

IN a letter published in NATURE for February 10, 1923 (p. 187), I referred to the possibility of determining the temperature of the upper atmosphere on any occasions when the disruption of a meteor has been heard and the time interval between sight and sound has been recorded. I have now to report that I have only been able to learn of two instances which have looked favourable, and that neither of them has yielded useful information.

The first case is that of the meteor of December 21, 1876, which is described in the *American Journal of Science and Arts*, Series III., Vol. 13, p. 166, 1877, and in a paper by Prof. C. U. Shepard, on p. 207 of the same volume, as well as in a paper read by Prof. D. Kirkwood before the American Philosophical Society, March 1877. The meteor was under observation from Kansas to the shores of Lake Erie.

Over the State of Missouri one or more explosions occurred, and the disintegration continued until there was "a large flock of brilliant balls chasing each other across the sky." In some places "a terrific series of explosions were heard." It is clear that the identification of the source of any particular sound is out of the question. The following tantalising observation quoted by Kirkwood is therefore of no service: "Rev. James Garrison, who resides one mile south of Bloomington, noticed by his clock the time of the meteor's disappearance and also that of the subsequent rumbling sound, together with the violent jarring of his house. The interval was 15 minutes, indicating a distance of 185 miles." The implication that the speed of sound is a universal constant is to be noted.

The second case is that of the meteor of July 27, 1894, a very detailed account of which is given by Prof. E. S. Holden in "Meteors and Sunsets" (Contributions from the Lick Observatory, No. 5). It is clearly established that the meteor exploded at a height of about 28 miles and near to Merced, California. The determination of the time of passage of the sound to the Lick Observatory appears from the statements of the observers to be precise enough. Five observers who noted the time at which the sound was heard agree within two or three seconds. For the time at which the explosion was seen there is, however, only one observation with any claim to precision.

The time of explosion (A. F. Poole)	7h. 29m. 45s. $\pm$ 10s.
The time of hearing the report (five observers) .	7h. 36m. 14s. $\pm$ 3s.
Time of passage of sound .	6m. 29s. $\pm$ 13s.

The distance from the observatory to the point at which the explosion occurred is estimated by Holden as 59·3 miles—*i.e.* 95 km., due allowance being made for the height of the observatory above sea-level.

The data imply that the average speed of the sound was 244 ± 8 metres per second, and that the average temperature of the air between 28 miles and 1 mile above sea-level was $148° \pm 9°$ A. (about $-193°$ F.).

In 1894 such an estimate was accepted without difficulty. In 1923 it looks wrong. The most likely place for a flaw is in Poole's observation. There is no statement as to how it was made: if with an ordinary watch an error of a whole minute is not unlikely. With the appropriate amendment the time of travel of the sound becomes 5m. 29s., the speed 289 metres per second, and the temperature 207° A.

Some confirmation is found in the only report received by Prof. Holden in which a single observer states the interval between sight and sound of the explosion. Mr. George Bray saw the whole phenomenon at Santa Clara, and gave the interval as 7½ minutes. According to Holden's sketch-map, the horizontal distance was 70 miles, the path of the sound was therefore about 75 miles or 121 km., and the speed 278 metres per second. This corresponds with an average temperature 192° A. and is quite plausible, but with the limitations implied by an estimate of 7½ minutes, little weight can be attached to the result.

I have trespassed so far on your space because I wish to emphasise the fact that any one who has the good fortune to see a meteoric explosion will be doing good service if he notes the time by his watch (writing it down immediately) and listens for the sound. If he is able to compare his watch with a standard clock, so much the better, but from the present point of view the interval is of greater importance.

In conclusion, I should like to thank Miss Williams, assistant secretary of the Royal Astronomical Society, who devoted much time to looking through the literature of meteors on my behalf.

F. J. W. WHIPPLE.

6 Addison Road, Bedford Park, W.4,
October 25.

Experiments on *Ciona intestinalis*.

IN the issue of NATURE for November 3, p. 653, there appears a letter from my old friend and former colleague, Mr. H. M. Fox, in which he records an attempt which he made this summer to repeat Dr. Kammerer's experiments on Ciona. These experiments consisted in inducing an abnormal growth of the siphons of Ciona by repeated amputation. Mr. Fox amputated the siphons of Ciona, but the length of the regenerated siphons was normal.

As Dr. Kammerer took a deep interest in the projected repetition of his experiments on Ciona, and wrote to me twice this summer to learn if repetition were being attempted and under what conditions, perhaps you will allow me to make some remarks on Mr. Fox's letter, as Dr. Kammerer is now in America.

Dr Kammerer, whilst in Cambridge, wrote out a full account of the precautions to be observed in making these experiments. At that time he did not know that Mr. Fox was going to take up the work: another Cambridge biologist had undertaken to do so, but this gentleman was prevented by illness from doing the work. To him, however, Dr. Kammerer had transmitted his information. I understand—Mr. Fox will correct me if I am wrong—that Dr. Kammerer's instructions did not reach Mr. Fox.

In these circumstances it is not surprising to learn that Mr. Fox failed to obtain Dr. Kammerer's results, since he has tumbled into one of the most obvious pitfalls. It may surprise him very much to learn that *Dr. Kammerer got the same results as he did* when, like Mr. Fox, he cut off only the oral siphon. Since the anal siphon remains of normal length and the reaction is of the animal as a whole, the regenerated oral siphon is of normal length also. But *when both anal and oral siphons are amputated in a very young animal*, then long siphons are regenerated. I have a photograph which shows an operated Ciona and a normal one growing side by side in the same tank, and the contrast between the lengths of their siphons is obvious. When Dr. Kammerer returns from America I hope that Mr. Fox will communicate with him and repeat the experiments, observing Dr. Kammerer's precautions, when, I feel confident, he will obtain Kammerer's results.

My confidence is based on the following considerations. Curt Herbst in Germany tried to repeat Dr. Kammerer's experiments on *Salamandra maculosa*; he arrived at the conclusion that although the animal may change colour with environment, yet these changes are temporary, and that therefore it was useless to try to repeat Kammerer's work on the inheritability of these changes. Herbst worked principally on Salamander larvæ. Mr. E. Boulenger in 1919, however, began to repeat Kammerer's work on young metamorphosed Salamanders. I have been privileged to watch Mr. Boulenger's experiments from the beginning, and now in 1923, after four years' work, Mr. Boulenger and I are both convinced that Kammerer is perfectly right so far as the first generation is concerned. Our specimens are not yet, unfortunately, completely sexually ripe. E. W. MACBRIDE.

Imperial College of Science and Technology,
South Kensington, London, S.W.7.

Globular Lightning.

I AM much interested in the references to lightning in Dr. A. Russell's presidential address to the Institution of Electrical Engineers, and also in the article by Dr. G. C. Simpson in NATURE of November 17, especially where the latter mentions that "the only physical phenomenon yet produced in a laboratory at all approaching ball lightning is the active nitrogen studied by Lord Rayleigh."

It has occurred to me that possibly the ball may be a mass of concentrated nitrogen oxides, and I suggest this because the observations seem to fit in well with the formation and action of such gases.

We know that when air passes through high-tension arc flames in an electric furnace, the nitrogen and oxygen combine to make nitric oxide gas, and that as the gas cools down it takes up more oxygen to form nitrogen dioxide, the speed of combination increasing rapidly with the cooling.

In Norway, and elsewhere, for many years, electric furnaces have been running which aggregate over half a million horse-power and make nitrates from the air in the same way that lightning does. It has been estimated that 100 million tons of nitrogen fixed by lightning flashes fall annually on to the earth's surface.

The energy suddenly released by a flash is enormous, and the potential has to be many millions of volts to tear a way, or a hole, through the air dielectric. May it not be that a very high pressure is suddenly set up, followed by a sudden reaction and chilling effect? If so, then the conditions are extremely favourable to the production of a large amount of nitric oxide and nitrogen dioxide gas in a very concentrated and possibly liquid form.

Whilst moving through the air the outer layer of the gas will gradually oxidise to nitrogen dioxide, which will dissipate, and if the length of travel through the air is long enough it may all dissipate in that way. Occasionally, however, a ball of gas may start from a point so near the earth that some of it is still in concentrated form when it arrives at earth-level.

If a ball of such concentrated gas meets with organic material, such as a haystack or a tree, it would immediately nitrate it and a violent explosion take place. One of the worst accidental explosions that took place in Germany during the War is said to have been caused in that way.

The peculiar smell, which some observers have called "sulphury," may be nitrogen oxides or ozone.

Of course, the point most difficult of explanation is how the gas, if such it be, becomes concentrated into a ball. Perhaps a reader of NATURE can suggest an explanation of that point.

E. KILBURN SCOTT.

38 Claremont Square, London, N.1.

Principles of Psychology.

AN absence from London prevented me from seeing the review that appeared in NATURE of October 13, p. 535, under the heading "Mental Athleticism," of my work "Principles of Psychology"; but I desire now to enter my protest against the ill-usage offered to my book, and to science itself.

I do not speak from mere author's vanity, for I have written this book not for my own glorification, but by way of introducing something into the world of thought that will eventually impinge on every fibre of our civilisation and help to mould the life of man to greater purposes.

When as a young student I set forth with this purpose, *por mares nunca de antes navigados*, I resolved to stake my own intellectual life on the issue, and not to write a line until I had completed the exploration of my problem. That work occupied twenty years of secluded work and intense intellectual effort.

If I am confident now, it is as Pythagoras was confident, for the good reason that he had furnished the complete demonstration of what others had tentatively sought to know.

The review, published anonymously in NATURE, contains a series of statements so wide of the mark as to seem to be almost purposely misleading. My first book did not, as the reviewer suggests, fall stillborn from the press; the whole edition has, in fact, been sold. It is true that by certain "authoritative teachers" here it was received with sneering comment, but it found the most gratifying acceptance in enlightened quarters. The *Revue Philosophique*, which is the most authoritative of all the philosophical magazines, broke its rule of allotting but one page to a review, and devoted to the book twelve times that space in a finely analytical study by Prof. Dugas, himself justly famous in Europe.

So far from finding with your critic, in his incomprehensible statement, that "the solution offered as new is certainly not novel," Prof. Dugas noted especially the "originality" as well as the "profundity" of the work. Of the present volume he says: "I live with your *Principles* just now. . . . I am more and more struck by the philosophic character of your psychology." Amongst many others Ribot and Boutroux, both world-renowned, expressed themselves in similar terms. Boutroux was "astonished"

at the scope of the book, and declared, "the conception is as scientific as the exposition is lucid."

I mention these, for I recognise that in academic circles here it is the custom to "drink the label," but I give no value to mere authority; I attach the utmost importance, however, to the serried march of my own arguments proceeding from the deepest ascertainable base in regular succession to the conclusions offered.

Would any one guess from the statements of the reviewer that this presentation of psychology, so far from depending on my personal feelings, is entirely objective in conception, and that I do not ask the reader to take my series of "Fundamental Processes" at my word, but offer the demonstration of their "necessity and sufficiency" in an exposition of which the meticulous and exhaustive character may be excused only by the paramount desire for rigour?

The reviewer is wrong even when he attempts to soften a disparaging note: "The choice of the name [Alétheian system] seems to imply a slight on other systems, but probably nothing of the kind is intended." What I intend to imply is that this work stands to other systems in a relation corresponding to that of Pasteur to the writings of the physicians of Louis XIV., or that of Galileo to the Schoolmen who discussed phenomena by talking of "proper" and "improper" motion, and decided questions not by illuminating from the foundation but simply by appealing to academic shibboleths.

That, too, is the meaning of resting my hope, not on "the young" as your critic cautelously insinuates, but on uncontaminated and capable young minds.

ARTHUR LYNCH.

80 Antrim Mansions, Haverstock Hill, N.W.,
October 30.

COL. LYNCH'S complaint of ill-usage to his book in the review in NATURE amounts to a charge that the reviewer has failed to appreciate the originality and the scientific importance of the author's system of psychology. This charge is true. All I can do is to assure your readers that I wrote without consciousness of prejudice, and only after a thoughtful reading of the book and sincere attempt to discover the author's meaning. I respect the author and had no intention of giving offence.

I am surprised and sorry that my reference to the author's former book is resented. May I say that the playful, not spiteful, allusion to the reception of the greatest philosophical book of the greatest British philosopher, Hume's "Treatise of Human Nature," was not meant to bear any reference to financial matters. Col. Lynch says that the whole edition of his former book has, in fact, been sold. I am glad, but I had no thought about it. Possibly Col. Lynch does not know that the whole edition of Hume's book was sold and that he was not smarting under financial loss when he said that it had "fallen still-born from the press."

THE REVIEWER.

Psycho-Analysis and Anthropology.

DR. MALINOWSKI'S illuminating letter in NATURE of November 3 contains a reference to what he rightly calls my "harsh judgment" upon Freud's incursion into ethnology. But he has not made it clear that I was criticising the views expressed in "Totem and Taboo" and not Freud's teaching as a whole. For I am in complete agreement with the latter part of Dr. Malinowski's letter, in which he insists upon the value of Freud's reform in psychological method for the solution of anthropological problems.

The examples quoted by Dr. Malinowski himself illustrate the aspect of Freud's work which is not merely fallacious but also in conflict with the essential part of his own teaching. Moreover, Freud entered the ethnological arena without preparing himself for the fray by making himself acquainted with the facts he attempts to explain. No one with any knowledge of the practices of totemism, exogamy, and taboo, can fail to recognise that Freud is unacquainted with the essential facts and associations of these remarkable customs, and that his suggestions as to their origin are irrelevant and nonsensical.

The essence of Freud's reform in psychological method was his insistence upon the fact that all the vagaries of behaviour and belief, the phantasies of the sleeping and waking life, had definite causes, which could be discovered and traced back to their real source in the individual experience of each of his subjects. But after exploiting this method of analysis of individual experience up to a certain point, Freud suddenly changes his tactics and quite inconsequently postulates a "universal symbolism," into conformity with which he tries to force the incidents of each individual's distinctive experience. This appears to me to be in direct conflict with the essential feature of his theory and practice. Moreover, this speculation of "universal symbolism" is responsible for most of the unsavouriness of Freud's methods which have excited such violent antagonism, and I believe not without some measure of justification. It is the duty of those who appreciate the value of the really fundamental part of Freud's reform to expose the inconsistency of these accretions which imperil the whole doctrine.

The criticism of his adventure into ethnology is inspired not only by the realisation of his lack of knowledge of the subject, but also by the fact that it is the more than doubtful and inconsistent part of his psychological teaching which he proposes to use as a panacea for the cure of ethnological difficulties. At a time when the ethnological doctrine of "psychic unity" is at its last gasp, Freud comes along with the fantastic nostrum of "typical symbols" and tries to revive it.

In the *Monist* of last January, I have analysed the claims made by Freud in "Totem and Taboo," and exposed their futility. But as even the qualified support Dr. Malinowski accords to this aspect of psycho-analytic method involves a very grave danger to anthropology, I have repeated here some of the arguments set forth in greater detail in that criticism.

G. ELLIOT SMITH.

The Origin of Petroleum.

I HAVE read, with much interest, the article on the "Origin of Petroleum" in NATURE of October 27, p. 627.

In a discussion of this nature one of the great difficulties, as mentioned by Mr. Cunningham-Craig, is for geologists and chemists to meet on common ground. This applies, for example, to a point raised in the article in NATURE as well as during the discussion at the Institution of Petroleum Technologists, in the words to "formulate any one hypothesis to explain the formation of such complex mixtures as mineral oils, and still more difficult to account for the great diversity in chemical composition exhibited by mineral oils from different localities." Considering coals as analogous, are not the chemical and physical variations between lignite and anthracite fully as great as those found throughout the range of petroleums? Yet no one casts doubt on the vegetable origin of coal on the score of the almost infinite variety of coal.

In the case of petroleum, formed from the same raw material, in itself extremely variable, other subsequent variables enter; one is the extreme delicacy and susceptibility of both the forming and formed petroleum to ever-continuous changes of temperature and pressure within the earth's crust; and the other is that petroleum can in general definitely be proved to have migrated at least several thousand feet, and during this process it may undergo chemical alteration, especially during contact with catalysers. In forming oil in the laboratory the principal variables at the disposal of the chemist are temperature, pressure, and catalysers; by varying these he obtains widely differing products from the same organic matter. In Nature, with infinite time added to the list of variables at present known, we seem to me to be not only fully justified but utterly unable to avoid expecting an almost infinite variety of petroleums.

I believe it has now been recognised that cholesterol and phytosterol are not necessarily any criterion as to animal or vegetable origin, since both can be made from a number of raw materials.

It is difficult to limit remarks on a subject so wide and important, but in conclusion I should like to make one further comment. Petroleum in the making at surface has been mentioned in various parts of the world, but these reports are frequently due to faulty observation or untenable hypotheses, and Djebel Zeit, Egypt, is no exception. I think all geologists are agreed that the oil there is, at latest, Miocene, and most probably of Cretaceous age, and that its presence in the corals is due to submarine and shore seepages, some of the oil from which lodged in the porous corals, and that on the local evidence it cannot possibly be explained by formation *in situ*.

G. W. Halse.

Abbey Buildings, 8 Princes Street,
Westminster, S.W.1, November 2.

The Ralline Genus Notornis, Owen.

The ralline genus Notornis was established by Sir Richard Owen in 1843 upon a series of bones sent him from New Zealand by the late Mr. Walter Mantell, in one of the earlier consignments of Moa bones discovered in the sand-dunes where the Maoris feasted. Owen designated his type species *Notornis Mantelli*. In the course of determining a collection of ornithological remains from turbaries, caves and kitchen middens from New Zealand and the Chatham Islands, containing many relics of those birds, I was bewildered, a few days ago, by discovering that this long-established genus had been boldly superseded by Messrs. Mathews and Iredale in their beautiful work on the "Birds of Australia," by the new generic designation, Mantellornis—one of the numerous topsy-turvies their volumes contain.

In 1843 Notornis was supposed to be an entirely extinct rail. After the lapse of many decades, however, more than one specimen has been obtained in the flesh, an example of which, known to zoology for some thirty years as *Notornis hochstetteri* of Meyer, is now preserved in the Dresden Museum. This specimen was dissected by that distinguished biologist, the late Prof. Jeffery Parker, who found it, in its osteological details, so closely affine to *N. Mantelli* as to cause him (as he told me) much doubt as to its differing in any character from Owen's species. The authors above cited have now renamed the Dresden specimen *Mantellornis hochstetteri* for the sole reason that Owen's genus was founded on *fossil* bones—after all not really fossil. It must now be equally legitimate for the next daring Neozealandian systematist to follow this example and assign a new genus, say Iredalornis, to the Apteryx bones occurring in New Zealand pleistocene and more recent deposits, and in caves and cooking-ovens, the minutest anatomical details of which agree with those of the Kiwis living within sight of the scenes in which their very own parents perished—a violent breach of the Rules of Nomenclature not less unscientific than the substitution of Mantellornis for Notornis.

It seems to be coming to this, if we are to be guided by these extremist authorities on nomenclature, that the very same creature is to be assigned to one genus when it is studied from the inside, and to another when (found alive) it is studied from the outside. Against such absurd genus-making—than which no more glaring example has surely been perpetrated in any reputable zoological publication—I, for one, desire to enter my strongest protest, in the interests of biological science, and against the confusion that must inevitably result if such procedure, as is described in this letter, is to be followed.

Henry O. Forbes.

Redcliffe, Beaconsfield, Bucks,
October 28.

Dr. Jesse W. Lazear and Yellow Fever.

The story of the death of Lazear as commonly told is that mentioned in Nature of October 27, p. 631, namely, that he "allowed himself to be bitten by mosquitoes that had fed on the blood of yellow fever patients." It may, however, be worth while to state that the mosquito-bite which killed him was inflicted, not experimentally, but by a "wild mosquito" in the ward in which he was working (September 1900). This was told to me in Panama in 1904 by Dr. T. C. Lyster, who was actually with Lazear when the insect bit him on the hand; and Lazear then remarked, "I wonder whether this creature is infected"—or words to that effect. It was Dr. J. Carroll, who had been previously, and experimentally, infected by mosquitoes fed on yellow-fever patients; but he recovered. Nevertheless, Lazear's case was almost as good as an experimental one. The whole heroic story will be found set forth in Dr. Howard A. Kelly's "Walter Reed and Yellow Fever" (The Norman, Remington Company, Baltimore), and is given briefly in my Memoirs, p. 425.

Ronald Ross.

Life History of the Ephemeridæ.

I have been asked by a French observer, M. A. Gros of Marigny (Jura), France, if I can put him into touch with entomologists interested in the Ephemeridæ. M. Gros is the author of an illustrated brochure, "Études sur les premiers études des éphémères du Jura français," which deals mainly with *Ecdyonurus forcipula* of Central Europe—not, I believe, found in the rivers of the British Isles. M. Gros would prefer to correspond in French if possible. He appears to have established some interesting facts, which may help us in our endeavours to transplant water-flies from one river to another. So many causes are denuding our rivers of their natural supplies of Ephemeridæ, etc., that it is most important to introduce fly from other waters if possible. It has been done, at least temporarily, in a few instances.

R. B. Marston,
Editor, *Fishing Gazette*.

19 Adam Street, Strand,
London, W.C.2,
October 29.

Natural History in Kinematography.

THE value of the kinematograph as a means of obtaining permanent graphic records of phases of animal movement, and of the various stages of growth and change of form that go to make up the story of the life-history of insects and other invertebrates, is, at long last, becoming more generally appreciated; while to find a British firm devoting its energies entirely to the production of such films is an encouraging sign of the growth of public interest in the pictured story of animal life. The British Instructional Films Ltd., the firm in question, has started the issue of a series of remarkably interesting natural-history films under the general title of "Secrets of Nature," which we are glad to hear will be shown as part of the regular programme at kinematograph theatres in London and the provinces. This is a step in the right direction, and should help further to demonstrate the importance of the kinematograph as a means of popular instruction.

FIG. 1.—Imago of mayfly just emerged from sub-imago stage, showing cast skin, which is waterproof to enable it to escape from water.

The subjects included in the series cover a fairly wide range, and should appeal not only to all who are interested in bird and insect life, but also to the lover of the open countryside and the wild life of field and hedgerow, to the antiquary, and to the angler. There is a wonderfully complete film of the life-history of the Mayfly that must have cost an infinite amount of patience and care to obtain; a reproduction of one of the pictures is given in Fig. 1. This is appropriately followed by a still more striking record of spring salmon-fishing in Scotland amidst the most picturesque surroundings (Fig. 2). In the latter film, use was made of the ultra-rapid kinematograph camera to obtain for the first time a complete record of fresh-run salmon ascending the waterfalls and rapids in their journey up stream to their spawning grounds. By means of the ultra-rapid camera it is possible to take records at as much as eight to ten times the normal speed, so that, given sufficient light for the extremely short exposures entailed, a film may be obtained of every phase of the swift rush and leap of the fish; movements too rapid for the eye to follow or appreciate. These ultra-rapid records are projected on to the screen at the normal rate at which kinematograph films are shown, namely, at sixteen pictures a second, which enables the observer to follow clearly every detail of movement; and the lightning-like dart and leap of the fish passes across the screen as a slow and amazingly graceful series of movements.

Watching these perfect pictures, one cannot help thinking of those early pioneers of chronological photography, Marey and Muybridge, and of how much they would have given to have had at their disposal such apparatus for taking their records of trotting horses and running men. There can be no doubt that this latest development of the kinematograph will prove of invaluable service in the critical analysis of movement. During the past summer there have been taken in the Zoological Society's Gardens at Regent's Park several extremely interesting records with this apparatus, including the movement of the long tongue of the chamæleon, the forked tongue of a python, and the Barbary sheep descending the almost vertical sides of the high rocks in their enclosure in the Mappin Terraces.

Another subject included in the series will undoubtedly arouse considerable interest, for it has an historical as well as a biological aspect: that is the film record of the story of Westminster Hall and its wonderful roof. This film was taken under the direction of

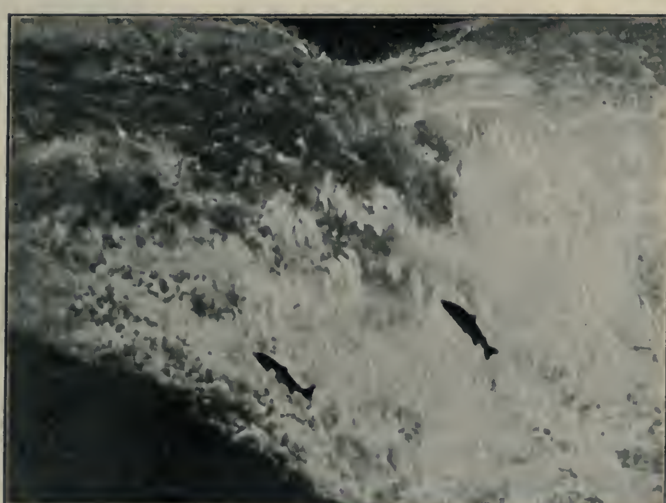

FIG. 2.—Salmon ascending a waterfall on their way to their spawning ground.

Sir Frank Baines, and shows not only the work of restoration in progress, but also the actual cause of the threatened danger to the venerable roof, the larvæ of the deathwatch beetle at work excavating its galleries in the heart of the old oak beams (Fig. 3). The film of the gallant little three-spined stickleback engrossed in the domestic duties of nest-building (Fig. 4), enticing the female to deposit her eggs therein, and then

mounting guard over the spawn, and later protecting the newly-hatched fry from marauding visitors (Fig. 5),

FIG. 3.—Larva of deathwatch beetle eating into roof-timbers of Westminster Hall.

is an ideal nature study subject which is bound to rivet the attention of every boy who has the good fortune to see it. One can but hope that in the near future this class of film may become a regular feature in the programme of the kinematograph theatres throughout the country, and ultimately replace much of the vulgar trash and sordid themes that at present occupy far too prominent a place on the bill.

The production of these natural-history films is by no means a simple matter, for if they are to be of real educational value, not only must the record show the subject clearly, but also they should be taken by, or under the direct supervision of, one who is thoroughly conversant with the habits, characteristic movements, and life-history of the creature, so that no important phase is missed or wrongly interpreted. This the British Instructional Film Company appears fully to have realised, their films having been taken and edited by a band of acknowledged experts. The actual taking of these records of animal life calls for great technical skill and judgment and for the exercise of untiring patience, for the difficulties to be surmounted are infinitely greater than in ordinary photography. Hours of patient watching and waiting have to be faced, and often when the end seems in sight something will happen; the stock of film in the camera runs out, or the sky becomes too overcast to permit of sufficient light for the extremely short exposures necessary, and the final stage is missed—perhaps the last possible chance of the season, and the whole of the work has to be begun all over again the following year. "Light, more light!" is the constant prayer of the naturalist kinematographer, for he must be able to obtain sixteen fully exposed little film negatives per second if his record is to give an approximately truthful screen picture; while to catch every stage in a swift movement like the leap of a salmon or the beat of an insect's wing, the sixteen pictures may have to be quadrupled at least.

Although the photographic emulsion with which the celluloid film is coated is very fast, the need for such extremely short exposures renders it necessary to employ lenses working at very large apertures, at F.2, or F.3, if sufficient light is to reach the film. Consequently, the depth of field that will be critically sharp when working close up to the subject, as one has to do when recording the movements of small insects, will be limited practically to a few inches, necessitating constant most careful readjustment of the focus, should the creature approach nearer to the camera or elect to move further away; while owing to the enormous subsequent enlargement of the picture when projected on the screen, every detail must be recorded on the negative film with microscopic sharpness. Last, but by no means least, the subject, if a bird or a mammal, has to be accustomed to the presence, and the sound when in operation, of the kinematograph camera; this often calls for considerable patience, for all wild creatures are suspicious of unfamiliar objects or sounds.

FIG. 4.—Male three-spined stickleback clearing ground preparatory to building nest.

FIG. 5.—Nest completed, and female depositing spawn, while male guards the nest.

Even in captivity, this inborn mistrust and uneasiness in the presence of an unfamiliar sight or sound is main-

tained, and may result in agitated, unnatural movements, giving a totally false impression of the true natural characteristics of the animal.

This has been demonstrated on several occasions in making records of some of the shyer animals in the collection of the Zoological Society of London. In obtaining successful records of the rare and interesting maned wolf of South America, the kinematograph apparatus had to be set up again and again and the mechanism run without any film, before the animal could be induced to tolerate its presence or move about in a natural manner. On the other hand, the anthropoid apes, like children of the human race, are so intensely curious and interested in what is going on, that they will cease playing about in their normal fashion until they have been permitted thoroughly to examine the apparatus and satiate their curiosity.

We are indebted for the accompanying illustrations to the directors of British Instructional Films Ltd., 26-27 D'Arblay Street, Wardour Street, London, W.1.

Meteorological Perturbations of Sea-Level.

By Dr. A. T. Doodson.

It is always understood that the predicted heights of high and low tidal water do not take into account the variations in the height of the sea due to wind and to air-pressure, and that the errors due to these causes may be of considerable magnitude. With the large ships that are now in common use the margin between sea-bottom and ship-bottom is small, and since many of the largest ports in the world are situated in comparatively shallow water, navigation, both in channels and into dock, is carried on only with constant reference to the state of the tide. A particular example of the problem is that of loading a vessel in dock: how much cargo must be left on the quay-side so as to leave sufficient clearance for the vessel to get safely out of dock? The cargo so left has afterwards to be transported by lighter, with consequent increase of expense. If the tide is lower than was expected there is increased risk to the vessel, and if the tide is higher than was expected needless expense has been caused through leaving cargo to be transported by lighter. It is therefore obvious that a forecast of the effects of wind and air-pressure on sea-level and tides would be of very great advantage to navigators in and near a port, and for this reason much attention has recently been given to the subject.

The effects of wind and air-pressure on sea-level are also important factors for engineers engaged in the construction of harbour works. Again, they are of importance in connexion with geodetic surveys, since sea-level is an obvious datum from which to take measurements; but it has been shown by the Ordnance Survey ("Second Geodetic Levelling of England and Wales," p. 34) that measurements by levelling gave mean sea-level at Dunbar and Liverpool respectively 0·8 ft. and 0·4 ft. higher than at Newlyn. These discrepancies cannot be attributed wholly to errors of levelling, and there is reason to believe that part of the explanation is connected with climatic causes. Investigations as to the variation of sea-level with wind and pressure have been made by Mr. H. L. P. Jolly, of the Ordnance Survey, and are referred to below.

Most investigations on this subject have been concerned with air-pressure and not with wind, the sea being regarded as a negative water barometer; the "constant" for the barometer, however, varies much from place to place, and even according to the numerical method used in obtaining it. A British Association Committee in 1896 reported that the effects of wind and pressure were real, but no law could be established; the methods of investigation, however, were faulty. A successful reduction to law for both wind and pressure in connexion with tides at Ymuiden was published by Ortt in 1897, his method being to collect together observations for given ranges of values of pressure, wind direction, and strength. This method has been used, in essence, by other continental workers. Prof. R. Witting (Bulletin de la Société de Géographie de Finlande, Fennia, 39, No. 5, 1918) has elaborated a method of comparing the gradients of the sea-level in the Baltic Sea with the gradients of the pressure-system over the sea; this method is strictly in accordance with theoretical considerations, but it requires a large number of observing stations, and is most confidently applied to narrow seas. His use of pressure gradients instead of wind-strength and direction of wind is very commendable, and was utilised by Mr. Jolly in his investigations, leading to the simple formula

$$\zeta = \kappa(B - \bar{B}) + \lambda(E - \bar{E}) + \mu(N - \bar{N}),$$

where ζ is the meteorological disturbance of sea-level; B, E, N are the values of the local barometric pressure and its gradients to the east and north respectively; bars denote means in the interval of time considered, and κ, λ, μ are constants determined from observation.

This formula is valuable because it lends itself very easily to numerical methods, and fairly accurate values of the constants may be obtained from observations extending over only a month, whereas an elaborate method like Ortt's requires far more observations and much more labour. It represents the perturbations of mean sea-level with a fair degree of accuracy.

The formula has been used extensively at the Tidal Institute at Liverpool, and has yielded some very interesting results. It is easy to deduce from it the direction of the most effective wind for raising sea-level at the place considered, and this has been evaluated from a month's observations at various places on the British coast, the results being illustrated in Fig. 1. The arrows give the direction from which the most effective winds blow, and the lengths of the arrows are proportional to the effects for a given strength of gradient in the most appropriate direction. Many previous investigators dealing with the perturbations of mean sea-level on the Continental coast of the North Sea have found that the most effective winds for raising sea-level there are those which blow towards

the shore, and conclusions have been formulated that the effect is due to the local wind blowing the water towards the shore. This conclusion is not substantiated by Fig. 1, for the winds which raise sea-level on the east coast of Britain are those which blow away from the shore. A westerly wind therefore raises the water of the whole of the North Sea in some degree or other, and this effect must therefore be due to wind blowing over a large area to the north of Scotland. The direction of the most effective wind at Felixstowe has a much larger northerly component than is present at Dunbar. In other words, a northerly wind would have little effect at Dunbar as compared with Felixstowe, the reason probably being that the sea becomes shallower towards the south, agreeing with theoretical conclusions that, apart from the effects of rotation, wind operates more effectively in shallow water than in deep water.

FIG. 1.—The most effective winds for raising sea-level round the British Isles.

The Irish Sea gives some interesting results. It would appear that from Newlyn northwards the most effective wind has a large southerly component. Local influences are far more marked at Newlyn and Cork than at Holyhead and Belfast, while the effect of the broadening out of the Irish Sea is shown slightly at Holyhead and still more at Liverpool, where the westerly component of the wind shows its influence, and again the shallower water of the upper part of the Irish Sea helps the effect.

Some of these conclusions could have been formulated roughly from qualitative statements in seamen's almanacs, but what gives value to the results dealt with above is that they are expressed quantitatively. Further, qualitative statements are liable to give not the most effective wind for a given wind-strength, but that wind which has happened to give a storm-effect.

The predominating factor in the above results is the southerly wind operating on the Atlantic water south of Ireland. This conclusion has been verified for Liverpool by applying an extension of the formula so as to include Atlantic winds (south of Ireland) as well as local winds. The results show that, for a given wind-strength operating in the most favourable direction in each case, the Atlantic wind has 50 per cent. more effect than a local wind, in spite of the deeper Atlantic water being less favourable to wind effects. Further, the most effective Atlantic wind blows from the south and the most effective local wind from almost due west.

When we correlate the pressure system at a fixed time with the mean sea-level at a variable time we find that the correlation between the sea-level at Liverpool and an easterly gradient of pressure, corresponding roughly to a south wind, is greatest when the mean sea-level is taken about fifteen hours later than the corresponding pressure gradient. The corresponding time for Newlyn is nine hours. For a northerly gradient, however, the time difference for maximum correlation with mean level at Liverpool is practically zero. These results are in conformity with those just discussed, for we should expect a large time-interval for setting up the circulation of water from the Atlantic and a small time interval for effects generated in the Irish Sea.

It can be deduced, therefore, that the most favourable conditions for giving exceptional effects on sea-level are those in which a south wind blows for some hours, filling the Irish Sea as a whole, and then changes to the west—the rapidity with which the west wind operates is apparently favourable to storm-effects.

The correlation between mean level at Liverpool and the fluctuation of the local atmospheric pressure is greatest when the sea-level is taken about three hours earlier than the pressure. For Newlyn the time-advance is five hours. These results are of very great interest: the anticipation in mean sea-level of changes in barometric pressure is probably due to the different rates of travel of disturbances through air and through water. Ferrel (U.S. Coast Survey, Report, 1871, p. 93) in 1871 noted that the changes in sea-level in Boston Harbour, U.S.A., appeared to anticipate the barometric pressure. Anticipation of coming storms, according to Dr. Bell Dawson (Trans. Roy. Soc., Canada, 1909, pp. 186-188), is also shown in the currents off Newfoundland; a change in magnitude and direction is noticeable some twelve hours before the onset of a storm, and generally (with some exceptions) the current sets more strongly towards the direction from which the wind is about to blow. This phenomenon is regarded by the local fishermen as an unfailing indication of bad weather. These anticipatory effects are worthy of fuller investigations.

Current Topics and Events.

THE Royal Swedish Academy of Sciences, Stockholm, has awarded the Nobel prize for physics for 1923 to Dr. R. A. Millikan, director of the Norman Bridge Laboratory of Physics at the California Institute of Technology, Pasadena, and the Nobel prize for chemistry for 1923 to Prof. F. Pregl, professor of applied medical chemistry in the medical faculty of the Karl Franzens University, Graz, Austria. Dr. Millikan is best known for his work on the determination of the absolute value of the charge of the electron. Before his experiments various measures had been made of this, by condensing a cloud on free electrons in a gas and observing how the cloud behaved. Millikan found that it was possible to watch the single drops, and thus discovered many inaccuracies to which the earlier work was subject, and this enabled him to modify it into a method of precision. In his final arrangement, a small drop of oil or mercury was watched in a microscope as it slowly fell under gravity or, acquiring a charge, rose in an electric field. In this way he could observe directly the atomic nature. of electricity; for if the speed of the drop ever changed it would always change by a discrete amount In the course of these experiments he worked out the problem of the motion of a sphere in a viscous fluid, and found under what conditions Stokes's law is verified; more recently he has made his work throw light on the nature of the collision of a gas molecule with a solid or liquid surface. It is a fairly safe prediction that it will be long before methods are devised which will give more accurate values than Millikan's for the electronic charge and the associated constants. Only second in importance is his very accurate determination of the quantum by means of the photoelectric effect. His work not only completely verified the Einstein theory, but also showed that the "limiting potential" of that theory is identical with the ordinary contact potential. Since then Dr. Millikan has added a great deal to our knowledge of the spectrum in the region of very short waves.

THE London School of Tropical Medicine, cooperating with the New Zealand Government, has just sent an expedition to Samoa to study the depopulation of the Pacific from the medical point of view. The expedition is led by Dr. Patrick Buxton, and will probably be in Samoa about two years. It is proposed to select a small island and try to exterminate *Aedes variegatus* (*pseudo sentellaris*), the particular mosquito which carries filariasis: a majority of the natives are infected with this disease. This large-scale experiment should afford information about costs and methods, and will be of value in many parts of the world. An investigation of all biting insects will be made, and the party is equipped to study the problems of ventilation and temperature in various types of house. An effort will be made to collect insects in general, even those of no economic importance, because it is presumed that a peculiar fauna still exists in the virgin forests which cover the centres of the islands, and that this fauna is in danger of being exterminated by enemies introduced from other islands.

WITH the December issue the monthly publication of the meteorological ocean charts ceases. The information supplied on the back of these charts will in future appear in a monthly magazine entitled the *Marine Observer* which will be on sale by the Stationery Office. The magazine will be supplied free to the commanders of all ships on the list of regular observers to the Meteorological Office. The face of the charts for each month of the year, with information which is of a permanent nature, have been printed in limited numbers, and one set will, we understand, be supplied, according to its trade, to each ship on the list of regular observers, on request being made by the commander. These charts of frequencies and normals of the North Atlantic or East Indian Seas for each month of the year may be purchased at one shilling each from the Admiralty chart agents. The December issue of the East Indian chart contains a useful index to the information published on the back of the charts from 1906 onwards.

THE many friends of Sir Arthur Schuster will learn with much regret that a few days ago he met with an accident which may lead to the loss of sight of one of his eyes. It appears that he was accidentally struck by a golf-club while standing near a lady player, the result being that his glasses were broken and a piece of glass entered one of his eyes.

THE selection committee of the Harrison Memorial prize, which, in accordance with the trust deed, consists of the presidents of the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, and the Pharmaceutical Society, will meet shortly to consider the first award of the Harrison Memorial prize. The prize, of the value of about 150*l.*, is to be awarded to the chemist of either sex, being a natural born British subject and not at the time over thirty years of age, who, in the opinion of the selection committee, during the previous five years has conducted the most meritorious and promising original investigations in any branch of pure or applied chemistry and published the results of those investigations in a scientific periodical or periodicals. Provided that in the opinion of the selection committee there is a candidate of sufficient distinction to warrant an award of the prize, the first award is to be made in December next. The selection committee is prepared to receive applications, nominations, or information as to candidates eligible for the prize, which must be addressed to the president of the Chemical Society, and should reach Burlington House, Piccadilly, London, W.1, before December 10.

ON November 14, Prof. R. A. Peters delivered his inaugural lecture as Whitley professor of biochemistry in the University of Oxford. Speaking of the interchange of teachers between Oxford and Cambridge, which he thought was to the advantage of both Universities, he directed attention to the fact that Oxford had inclined to the synthetic and Cambridge to the analytic aspect of biochemistry. The "steam-

engine" view of the body has been proved inadequate; nutrition cannot be expressed in terms of calories. The proteins of food enter the blood as amino-acids; the body forms its own proteins. The connexion between "miners' cramp" and the loss of salts is well established, and gives promise of further light on other morbid conditions. Increased cleanliness in food has tended to cause a deficiency in vitamins. Bread and rice have both suffered in this respect, but under civilised conditions the deficiency can be made up in other ways. A new importance to physiological chemistry is given by the discovery of the functional activity of endocrines. A large audience, including the Vice-Chancellor, was present at the lecture.

WE learn from the *Belfast Evening Telegraph* of October 24 that a new Naturalists' Field Club, styled the "Route," has been founded for northern Antrim, and that it is affiliated to the Belfast Club. The latter now numbers 703 members, and has been described by those who derive much mental profit from its various meetings and excursions as a second university for Belfast. It has the advantage of retaining as advisers members who have watched and fostered its progress for more than fifty years.

IT is announced in *Science* that Mr. John D. Rockefeller, Jr., has given 100,000*l.* toward the endowment fund of 400,000*l.* required by the New York Zoological Society, and will contribute a further 100,000*l.* as soon as the society raises another 200,000*l.* Mr. Edward S. Harkness has given 20,000*l.* and the estate of Mrs. Frederic Ferris Thompson 10,000*l.* For some time the Society has been carrying educational, philanthropic, and civic burdens far beyond its financial resources. Mr. Rockefeller's gift is without restrictions and the income becomes immediately available.

NOTIFICATION is given by the Chemical Society that applications for grants from the society's research fund (made upon forms obtainable from the Assistant Secretary, Burlington House, W.1) must be received on or before Saturday, December 1. The income arising from the donation of the Goldsmiths' Company is to be more or less especially devoted to the encouragement of research in inorganic and metallurgical chemistry; the income from the Perkin memorial fund is to be applied to investigations relating to problems connected with the coal-tar and allied industries.

THE following officers have been elected by the London Mathematical Society for the session 1923–1924:—*President*: Prof. W. H. Young; *Vice-Presidents*: Prof. L. N. G. Filon, Prof. H. Hilton, and Prof. A. E. Jolliffe; *Treasurer*: Dr. A. E. Western; *Secretaries*: Prof. G. H. Hardy and Prof. G. N. Watson; *Other Members of the Council*: Mr. J. E. Campbell, Prof. A. L. Dixon, Miss H. P. Hudson, Prof. G. B. Jeffery, Prof. A. E. H. Love, Mr. E. A. Milne, Mr. L. J. Mordell, Mr. F. B. Pidduck, and Mr. F. P. White.

VISCOUNT LONG OF WRAXALL has accepted the presidency of the forthcoming Empire Mining and Metallurgical Congress to be held at the British Empire Exhibition on June 3-6, 1924, of which the Prince of Wales is honorary president. The following have accepted invitations to become honorary vice-presidents of the Congress: The Secretary of State for the Colonies; the Secretary of State for India; The Secretary for Mines; the Prime Ministers of Canada, Australia, New Zealand, and Newfoundland; the High Commissioners of the Dominions and British India; and the Lord Mayor of London. The presidents of the seven convening bodies (*v.* NATURE, September 22, p. 453) will act as vice-presidents and will preside over the sections with which they are concerned.

THE issues of the Journal of the Royal Society of Arts for October 5, 12, and 19 contain the three Cantor Lectures by Mr. J. E. Sears on precise length measurements. To those who have not access to the various publications of the National Physical Laboratory, these lectures provide up-to-date information on the methods in use there for maintaining the ultimate standards of length and for accurately comparing the secondary standards in use in industry with the ultimate standards. The instruments used are almost all unique, and the accuracy attained with them one-millionth of an inch. We are glad to note that, as the result of work done by one of the staff of the Laboratory, it is likely that gauges of the accuracy of the Johansson gauges from Sweden will be made on a commercial scale in Great Britain.

ON Thursday and Friday, November 8 and 9, the sixth joint meeting of the Challenger Society and representatives of Marine Biological Stations was held at Cambridge under the chairmanship of Prof. J. Stanley Gardiner. The meeting was attended by more than fifty representatives of various organisations. Papers were read by Messrs. J. Barcroft, G. Bidder, F. F. Blackman, H. G. Carter, H. M. Fox, J. Gray, W. B. Hardy, H. G. Hopkins, T. Moran, J. Piqué, F. A. Potts, J. T. Saunders, and J. M. Wordie. Special attention was paid to the problems of cold storage. These meetings, which were inaugurated and are assisted by the Development Commission, are held periodically at the various marine laboratories and elsewhere.

THE opening meeting of the Illuminating Engineering Society on November 13 was, as usual, devoted to reports of progress and exhibits illustrating developments in lighting. Mr. Gaster, reviewing progress during the vacation, alluded to the appointment of a Committee on Illumination by the Department of Scientific and Industrial Research, and mentioned that the next technical session of the International Illumination Commission is to be held in Geneva in July next year. A conference dealing, among other matters, with industrial lighting, is being arranged by the International Labour Bureau of the League of Nations in Geneva in the same month. Reference was made to the newly-formed Association of Public Lighting Engineers as an illustration of the growing interest in illumination and the need of bringing the aims of the Society before a wider circle of the public.

This point was again emphasised in the report presented by the Committee on Progress in Lamps and Lighting Appliances, which described efforts being made to effect standardisation of lamps and fittings. Amongst other recent steps ten standard types of lamps suitable for automobile headlights, meeting the requirements of practically all British cars, have been evolved. Mr. L. E. Buckell showed some of the very large gas-filled electric lamps consuming 3000-4000 watts and other types with filaments specially designed for projector work. A new feature was the process for spraying bulbs with finely divided china clay; this gives a soft light and good diffusion, with an absorption estimated not to exceed 7 per cent. The sprayed surface is said to have good wearing properties, and it is believed that these lamps will prove useful in cases where they are unavoidably exposed to view in the direct range of vision and yet it is desirable to avoid glare. Miss Beatrice Irwin gave a demonstration of the colour filter system associated with her name, a variety of lighting units consisting of cylinders of hand-painted parchment paper in pleasing combinations of colours being shown.

LEAFLET R. 58 received from Messrs. Newton and Wright, Ltd., 471-3 Hornsey Road, N.19, describes the "Harley" unit for dental radiology. The chief feature of the apparatus is in the movements of the X-ray tube, which is a very important feature in practice. Flexibility is here combined usefully with rigidity, and arrangements are made which allow of stereoscopic radiographs being taken. The high-tension transformer is oil-immersed, and when in action one pole is earthed; a separate transformer with the necessary adjustments for the control of the filament current of the Coolidge tube is supplied. In order to vary the penetration of the X-rays, four alternative voltages may be applied to the tube terminals. This appears to be an ample margin for the requirements of dental radiology.

MESSRS. C. F. CASELLA AND CO., LTD., 49 and 50 Parliament Street, London, S.W.1, have issued a new catalogue, No. 523, which contains particulars and illustrations of a very wide range of surveying and drawing instruments and appliances. Detailed specifications are given of the more important instruments manufactured by the firm. In the design of several of these, many improvements are embodied, which either give some additional facility to the user or increase the accuracy or length of life of the instrument. A notable addition to the list is the new double-reading micrometer theodolite, which has been designed for geodetic and exploration purposes where accuracy of the highest order is desired. In this instrument the diametrical points of the circle are brought together in one field by an optical arrangement. It is therefore possible to set the telescope on the object, take the readings of the bubbles and all four readings of the circle without moving from the front of the instrument. The length of time spent in taking a set of readings is thus considerably reduced. This improvement is accompanied by a reduction in the number of parts employed, and the possibility of the instrument being put out of adjustment is thereby diminished.

Our Astronomical Column.

REINMUTH'S COMET, 1923B.—The following two observations, both made at Königstuhl, are now to hand, the positions being referred to 1923·0:

	G.M.T.	R.A.	N. Decl.
Oct.	$31^d\ 9^h\ 22{\cdot}1^m$	$1^h\ 15^m\ 11{\cdot}36^s$	22° 26′ 36·0″
Nov.	5 8 15·1	1 17 50·90	19 47 23·2

Mr. Waterfield states, as the result of an unsuccessful visual search, that the object is certainly fainter than the 11th magnitude. This faintness is probably the reason of the delay in obtaining a third observation.

THE NOVEMBER LEONIDS.—Mr. W. F. Denning writes: "Very stormy, unsettled weather prevailed during the most of the period when the return of the November meteors was expected, and it was not possible to watch for the shower on several consecutive nights. Mr. I. P. M. Prentice, of Stowmarket, endeavoured to obtain an early observation of the shower on November 10. For that purpose he carried out a long watch of the heavens commencing at 5.55 G.M.T. and ending at 17.55 G.M.T. He recorded 82 meteors though the sky was partly cloudy at times. Six of the meteors seen were Leonids with a radiant point apparently at 145°+22°. If this position for the radiant is confirmed it will indicate that the Leonid radiant, similarly to that of the great Perseid shower of August, is a movable position which advances about 1° per day. On November 11, Mr. Prentice saw 35 meteors, but the sky became cloudy before 14.50 G.M.T. and watching had to be discontinued. At 12.38 G.M.T. he saw a bright fireball directed from a shower of Taurids. It would be interesting to get another observation of this if other observers happened to be looking for Leonids on the night of November 11 at about 12.38 G.M.T."

THE EXTRAFOCAL METHOD OF STUDYING MAGNITUDES.—The advantages of this method are the practical equalisation of the size of disc for different magnitudes and elimination of the effect of peculiarities of images arising from defects in the objective. The quantity measured is simply the density of the image. Mr. Edward S. King (Proc. Nat. Acad. Sciences, U.S.A., Oct. 1923) communicates the results for 100 bright stars from Harvard observations. A yellow screen and isochromatic plates were used, thus giving photovisual magnitudes. The mean excess of the resulting magnitudes over the photometric ones is as follows: B −0·02, A0 0·00, F −0·10, G −0·15, K −0·16, M −0·20. The following colour-indices were deduced: B0 −0·23, A0 −0·02, F0 +0·25, G0 +0·88, K0 +1·28, M +1·87. These are independent of visual observations.

A rediscussion of the observations of Nova Aquilæ, 1918, when near its maximum brilliance, gives colour-index −0·19, instead of −0·35, published earlier. Mr. King also measured the colour-indices of the planets by the same method. The values are: Venus +0·91, Mars +1·45, Jupiter +0·96, Saturn (without rings) +1·22, Uranus 0·74. These accord well with the ruddy colour of Mars and the "sea-green" of Uranus.

The paper also contains new formulæ for the effect of phase-angle on the magnitudes.

Research Items.

Mycenæan Elements in the North Ægean.—Mr. Stanley Casson has contributed to the November number of *Man* an interesting analysis of the traces of intrusive Mycenæan culture in Macedonia and Thrace. Mycenæan pottery is derived from nine mounds in the Thermaic Gulf, mostly in the neighbourhood of Salonika, and all but three on the seashore. All this Mycenæan ware belongs, with one exception, to the close of the third Late Minoan period. Mr. Casson's conclusion is that probably Mycenæan imports were purely local and were derived by trade along the sea route from the south to the Thermaic Gulf. He figures two rapiers from Grevena on the upper waters of the Haliacmon and one from Karaglari in the Central Bulgarian Plain which belong to the type of Mycenæan rapier common in the last two Minoan periods. The former appears to have passed up the Vardar Valley or by way of Thessaly; the latter along the Struma. East of the Struma no traces of Mycenæan culture are recorded along the European shore, and Mycenæan traders appear to have had no port of call between Salonika and Troy.

Climate and the Nasal Index.—At the International Medical Congress held in London in 1913, Prof. Arthur Thomson read a preliminary communication on "The Correlation of Isotherms with Variations in the Nasal Index," in which it was suggested as a result of a survey of the nasal indices of the inhabitants of America that the greatest nose-width was to be found near the "heat-equator," and that a narrowing was to be found in passing north and south to Baffin's Bay and Tierra del Fuego. A joint paper by Prof. Thomson and Mr. L. H. Dudley Buxton which appears in vol. liii., pt. i. of the Journal of the Royal Anthropological Institute, gives the results of an extended investigation on these lines, from which it would appear that in fact a platyrrhine nasal index is associated with a hot moist climate and a leptorrhine nasal index with a cold dry climate; the intermediate conditions being associated with hot dry and cold moist climates. Both on the living (males) and on crania there is a positive correlation between nasal index and temperature. The same applies to nasal index and relative humidity in the living, but in crania the correlation is small. The result of the application of this line of investigation to prehistoric skulls is interesting. The platyrrhine character of the Grimaldi skulls would assign them to a warm Mousterian period; but the skull from La Chapelle aux Saints, being platyrrhine, should belong to a warm period, whereas it is usually assigned to a cold Mousterian period.

Freudian Psychology and Evolution Theory.—In the Transactions of the Croydon Natural History Society (vol. ix. pt. 3) there is an interesting article by Mr. C. C. Fagg on the "Significance of the Freudian Psychology for the Evolution Theory." The article consists of three parts. In the first the author outlines the discoveries of Freud, in the second he sketches the salient features of the evolution theory, and in the third he attempts to interpret the second in the light of the first. The paper is interesting as an indication of a scientific attitude of mind towards the Freudian theory. That theory has suffered almost equally from the uncritical assimilation of all its tenets by enthusiastic supporters and from the still more uncritical attacks of those who found its doctrines unpalatable. Mr. Fagg relates certain aspects of it to phenomena well known in the biological sciences. He interprets the stalk of the fixed infusorian as of the nature of a neurotic symptom; some amœboid forms reacted to fear, as in the case of the foraminifera, by putting on a coat of armour made of carbonate of lime or silica, a compromise formation which put a limit to their evolutionary possibilities; only those amœboid forms which retained their mobility and plasticity in the face of danger were able to bridge the gulf to metazoic life. He holds that there are many instances from palæontology to show how, in reacting to fear of environmental dangers, races have sold their souls, so to speak, for some measure of security. He believes that a consideration of some of the findings of Freud would do much to help in the aggravated question of the inheritance of acquired characters. He hopes that by an extension of our knowledge along the lines indicated by psycho-analysis we may some day be able to make a world fit for children to live in, a family and social environment in which super-babies may develop into super-men.

Cattle Feeding.—The idea which appears to have suggested the investigation recorded in "Under-Nutrition in Steers," by F. G. Benedict and E. G. Ritzman (Carnegie Institution of Washington), is that it might be economically advantageous to underfeed cattle during the winter, when feeding stuffs are scarce and dear, if it could be demonstrated that a prolonged period of semi-starvation did not inflict on the animals any permanent disturbance of their internal economy such as would hinder their fattening in the succeeding summer. For the purpose of the investigation 14 steers in all were intensively studied, 12 of them during the year November 1918 to November 1919, and 2 during the succeeding year. For the first fortnight the ration aimed at bare maintenance, for the next six months at approximately half maintenance, after which a full fattening ration was given. It was found that although during the six months on half maintenance the animals lost approximately 25 per cent. of their original live weight, they soon regained this when given a full ration, after which they fattened normally, and, when slaughtered, produced saleable beef. Thus the absence of permanent ill effects of prolonged and severe under-nutrition is clearly demonstrated, but it is unfortunate that the authors were prevented from considering the economic results of their investigation. In the absence of any economic discussion it cannot fail to strike the British reader that the investigation loses much of its importance. Under-nutrition of store cattle during the winter is a common phenomenon in the pastoral districts of the west of England, and when practised on young animals is supposed to be responsible for many of the shortcomings of stores which are transported to the Midlands and the Eastern Counties for subsequent fattening. The publication contains, however, clear descriptions of many very ingenious instruments used in the determination of the digestibility of the feeding stuffs and in the measurement of gaseous metabolism. Many British experimenters would profit by studying the discussion of the accuracy of live weight measurements on which they are apt to place implicit confidence.

Plant Propagation.—Mr. C. T. Musgrave has an interesting note in the Journal of the Royal Horticultural Society, volume 48, parts 2 and 3, issued September 1923, under the title "Methods of Propagation in an Amateur's Garden," which again directs attention to the numerous problems that immediately arise when the empirical data, alone available in this subject, are passed under review. Mr. Musgrave distinguishes between hardwood cuttings of woody perennials, which have ceased growth for

the year, and soft cuttings, among which he distinguishes again between truly soft herbaceous plants, such as the geranium, and the "firmwood" cutting of a shrub such as Escallonia. For firmwood cuttings he agrees with the practice of using a side shoot, torn from the parent stem with a downward pull so that a little "heel" of the main stem is left attached to it. Such "heeled" cuttings are described as almost invariably easy to strike. Fuchsia, on the other hand, strikes better if a piece of stem is cut off just below a node, rather than from a side shoot broken off with a "heel"; clematis again, for some puzzling reason, always roots best if cut about an inch below a node. The author points out that the layering method so frequently adopted with carnations is also very successful with rhododendrons, hardy azaleas, and other hardy shrubs.

Assimilating Tissue in the Plant.—As first part of vol. iv. of the Handbuch der Pflangenanatomie, edited by K. Linsbauer (Berlin: Gebrüder Borntraeger, 1923), there has appeared a review of the assimilating tissues by Fritz Jürgen Meyer. A full bibliography and index appears with the review. The various forms of assimilating tissue are fully described, palisade and spongy tissue, arm palisade, assimilating epidermis and bundle-sheath, etc., and a résumé given of the various views as to the development from special assimilating tissues. The conclusion seems to be that we have not yet escaped from a somewhat barren controversy as to the relative importance of alternative teleological explanations based upon its assumed functional activity. The main protagonists have been Stahl and Haberlandt. Stahl argued that the palisade system was the ideal system for strong light, the spongy for weak light, hence the relative proportions of these tissues in sun and shade leaves. That light exerts an important influence is supported by the recent experiments of Liese, which show the walls of the palisade cells adopting a different angle when developing in a radiation that comes in different directions. Haberlandt, on the other hand, developed as explanatory principles two adaptational requirements—(1) an increase of cell surface, his main clue to the structure of palisade and arm-palisade tissue; (2) an increase of length in the direction along which assimilates move in the cell, an important guide to the interpretation of spongy parenchyma. Other authors, notably Areschoug and Rywosch, have argued stoutly for the importance of transpiration and the moisture conditions of the leaf, finding various reasons why different types of tissue are best suited to certain moisture conditions. All these views are usefully and critically reviewed in this monograph.

Indian Agricultural Statistics.—The agricultural statistics of India for the year 1920–21 have been published in two volumes by the Department of Statistics, Calcutta; the first volume deals with British India and the second with certain Indian states. Among a mass of valuable returns dealing with acreage cultivated, areas under irrigation, extent of different crops and live-stocks, and harvest prices, it may be noted that the total area sown with crops in British India in 1920–21 was 5 per cent. less than the previous year, and represented 34 per cent. of the total land area. Owing to the fact that some areas are sown more than once in the year, the gross sown area really amounts to rather more than this figure. In the native states the sown area was about 40 per cent. of the total land area. Food crops accounted for 82 and 77 per cent. respectively of these two totals. The irrigated area in British India remained practically constant, while in the native states there was a slight increase. The area under cotton showed a decrease of 9 per cent., and the area under oil seeds, 2 per cent. The rainfall was above normal in Bengal and Assam and much of Burma, defective in the United Provinces, Rajputana, and Bombay, and especially so in the Punjab, Sind, and Central India, but excessive in Madras.

Australian Notonectidæ.—The Australian waterbugs of the family Notonectidæ form the subject of a contribution by Mr. Herbert M. Hale to the Records of the South Australian Museum, vol. ii. No. 3, June 1923. The predominant genus is Anisops, which has eight species; nothing previously appears to have been known concerning its life-history. Mr. Hale has been able to fill this gap to some extent in describing the biology and metamorphoses of the commonest species, *A. hyperion*, which occurs in both running and stagnant water. It was reared upon mosquito larvæ and pupæ, which were eagerly devoured, an average of 200 being consumed by each isolated nymph in less than four weeks. Among other genera, Notonecta and Plea are each represented by a single species and there is but one member of the family Corixidæ—*Porocorixa hirtifrons*.

Recent Shells from Java.—This first instalment of what promises to be an important catalogue of the "Recent Shells from Java" contains an enumeration of the Gastropoda by Dr. C. H. Oostingh. The work, written in English, is founded on a collection, chiefly of marine shells from Java, which is kept in the Geological Museum of the Agricultural High School at Wageningen (Holland), and of this by far the greater part was made by Prof. J. van Baren. An exact knowledge of the recent molluscan fauna being of much importance for the study of the Upper Tertiary fauna of Java, the author has approached the subject in some detail. That is to say, a copious synonymy, and notes of its distribution in the western Pacific generally, with geological occurrences where known, are given with each species, while there is a very good phototype plate of some of the forms.

The Glaciation of North-eastern Ireland.—Major A. R. Dwerryhouse contributes a remarkable paper on this subject to the Quarterly Journal of the Geological Society of London, vol. 79, p. 352 (Sept. 1923). The area covered is a wide one, from Torr Head to Slieve Gallion, thence across the wild moorland of central Tyrone; then away to the east coast again across Lough Neagh, and down to the narrow inlet of Carlingford Lough. The author recognises this inlet as a true fjord excavated by glacier-ice during the later phase, when the ice-flow from the north-west dominated that from the Irish Sea. Good use is made of the presence of pebbles from Ailsa Craig in inland districts, and the course of the Scottish ice (Firth of Clyde glacier) across the country during the earlier phase is strikingly shown upon the maps (p. 419, etc.). The careful work of years is embodied in this paper of seventy pages, and we can only regret that space has not allowed of the description of the picturesque scenic features added by drift-mounds and eskers to the floors of valleys or the barren surface of the moors. Special attention is paid to the gravel-terraces deposited in ice-dammed lakes, and to the dry gaps as records of overflow-channels throughout the district. It is pointed out that the recognition of the true nature of these channels in north-eastern Ireland dates from the work of the Geological Survey in 1904. Here, as elsewhere in Ireland, Mr. G. W. Lamplugh laid the foundations of a very marked advance.

THE WATER SUPPLY OF NYASALAND.—There exist in Nyasaland large tracts of fertile land which are deficient in water supply. If this defect could be remedied these areas would be available for settlement by natives or Europeans. In Water Supply Paper No. 1, issued as a supplement to the *Nyasaland Government Gazette* of June 30, Dr. F. Dixey considers the possibilities offered by underground water. The rainfall of Nyasaland varies from 30 to 80 inches a year, but the long dry season which follows the rainy season leads to great evaporation of surface water. In consequence, in any improvement of the supply, resource must be had chiefly to underground supplies. The granites, gneisses, and schists of the country are not too favourable in this respect, but in the Shire valley there are extensive alluvial deposits and, west of the Shire river, sandstone and shales overlie the crystalline rocks. It is in the last-named rocks that the problem is most difficult of solution. Dr. Dixey compares the conditions with those obtaining in Southern Rhodesia, where at shallow depths an appreciable supply of water is obtained from percolation in joints and fissures. He believes also that a certain supply may be obtained from shallow depressions, known as "pans" or "vleys," which indicate a considerable depth of weathered rock. In areas unfavourable for wells, the construction of impermeable collecting slopes and storage tanks is recommended. On such a slope a rainfall of 20 inches should yield 450,000 gallons per acre.

VARIABILITY OF TROPICAL CLIMATES.—A series of articles have appeared in the issues of the *Meteorological Magazine* for July, August, and September by Dr. Stephen S. Visher (Chicago) on the above subject. The opinion is held that the general emphasis upon uniformity in the tropics is misleading, and attention is directed to the variations of temperature and wind, while rainfall in lower latitudes is shown to be more variable on the average than the rainfall of higher latitudes. For seasonal range of temperature, amongst many other places, Hong Kong in latitude 22° N. with a range of 20° F. is compared with Glasgow in latitude 56° N. with a range of 12° F. It is pointed out that the latitude of Switzerland receives much more heat from the sun on June 21 than the equator, for the sun at that time is about equally vertical in the two places, while in Switzerland the days are about 4 hours longer. Cold snaps are shown to occur commonly in the tropics from various causes. With respect to variability of rainfall, comparison is made between the wettest and driest years in tropical regions and those in higher latitudes. The wettest years out of the tropics seldom exceed more than double the rain of the driest years, while in the tropics the variation of range is much greater. An important factor in these comparisons is the length of the period dealt with; this is recognised by the author. The total rainfall in wettest years is very much larger in tropical regions than in higher latitudes. The erratic nature of cyclonic storms in different parts of the world is referred to, and for frequency and violence the extremes are said to be greatest in low latitudes.

ATOMIC WEIGHT OF BORON.—We have received a copy of vol. 59, No. 2 of the Proceedings of the American Academy of Arts and Sciences, which contains a paper by Baxter and Scott on a revision of the atomic weight of boron. Taking silver as 107·88, these workers find that boron is 10·82 from analyses of the trichloride and tribromide of boron. Improved methods for the fractional distillation in vacuum of boron halides are also described.

SYNTHESIS OF LECITHIN.—Dr. A. Grün and R. Limpächer reported to the congress of German chemists, recently held at Jena, that older preparations, which had been taken for artificial lecithin, were nothing but choline salts of glycero-phosphoric acid. True lecithin is obtained by the action of diglycerides upon phosphoric anhydride, and subsequent action of choline bicarbonate. The purified product has all the physical and chemical properties of the lecithin prepared from seeds, egg-yolk, and the substance of nerves and brain. Optically active lecithins are also obtainable in this way; the kephalines can be prepared from diglyceride, phosphoric anhydride, and colamine.

NITROGEN CONTENT OF WHEAT GRAIN.—The importance of a high nitrogen content of the wheat grain has led Olson (*Journ. Agric. Res.* xxiv., 1923) to attempt to ascertain whether this can be varied by alteration in the controllable conditions in the environment of the wheat plant. The nitrogen content seemed to be increased by widening the distance between the drills when no irrigation was applied, but under irrigation in another district this effect was not obtained. On the other hand, irrigation *per se* exerted no influence in either direction. As maturity approached, the nitrogen in the plant moved towards the grain, though the actual percentage in the latter decreased, apparently owing to the more rapid infilling of carbohydrates. It would appear that larger quantities of water are required to move the nitrogenous matter than the non-nitrogenous into the grains, and accordingly an ample supply of water should prove beneficial to high rather than to low nitrogen content, which rather contradicts the findings with regard to irrigation. Phosphorus and nitrogen were found to enter the grain simultaneously, thus corroborating the results of other investigators.

LEAD AND PLANTS.—The application of radioactive isotopes as indicators, mainly by Hevesy and Paneth, has proved to be a powerful method of attacking many physico-chemical problems that do not readily lend themselves to direct methods. A further interesting application of this method is given in the current issue of the *Biochemical Journal* (vol. xvii. pp. 439-445, 1923) by Prof. Hevesy (Copenhagen), who has investigated the "Absorption and Translocation of Lead by Plants." Specimens of *Vicia Faba* (horse-bean) were immersed in lead nitrate solutions of different concentrations containing thorium B (isotope of lead) as an indicator, and after ignition of the various parts of the plant their lead content could be found by radioactive measurement of the ash. Quantitative results have been obtained using solutions varying in concentration as much as from 10^{-6} N. to 10^{-1} N. In 24 hours the root of the plant absorbed in the former case 60 per cent. of the lead contained in 200 c.c. of the solution, whereas in the latter case only 0·3 per cent. was absorbed. The amount of lead passing into the stem and leaves is less than 1/10 per cent., and does not vary greatly with the solution concentration, indicating that most of the assimilated lead is bound to the root, and experiments on displacement show that it is associated in the form of a dissociable but not readily soluble salt, and not in combination with carbon. Whereas a 10^{-1} N. solution of a lead salt produces toxic effects on the plant even after 24 hours, more dilute solutions do not. Experiments on the kinetic displacement of assimilated ions by other ions are described in connexion with the phenomenon of "antagonism," according to which certain ions have the capacity of inhibiting the toxicity produced by others.

Cohesion and Molecular Forces.

IN opening a joint discussion on cohesion and molecular forces between Sections A, B, and G of the British Association at its recent meeting at Liverpool, Sir William Bragg emphasised the change of point of view which the analysis of crystal structure by X-rays has brought about. The older view, in which atoms and molecules were pictured as centres of force exerted in all directions, and governed by some power law of the distance between them, has had some measure of success in explaining the principal features of surface tension and some of the departures from perfection in a gas. But in a solid, except possibly in the case of polar compounds, no satisfactory results have accrued. On the newer view we consider, not the aggregate, but the individual, atom or molecule.

It appears to be necessary to say that the very strong forces between atom and atom, molecule and molecule, are limited in their effective range of action to distances much smaller than we have hitherto supposed. Small, it may even be, compared to the distances between the centres of atoms as they lie side by side in a crystal. A crystal conforms so exactly to rules respecting its angular dimensions that it seems impossible to imagine its form to be merely the result of an average of tendencies. The forces of adjustment cannot, therefore, be thought of as a force between two points each representing one of the molecules. On the contrary, it is nearer the truth to think that the adjustment is made so as to bring together certain points on one molecule and certain points on the other. In considering, therefore, the binding of the individual molecules of a solid, the analogy of the electrostatic attraction of two charged spheres is imperfect, and should be replaced by that of two members of a girder structure adjusted until the rivets can be dropped into the holes brought into true alignment. This is seen well in the recent work by Muller and Shearer, and by Piper and Grindley on the structure of the organic fatty acids and their salts. There is no doubt that the ultimate flakes of the crystals of these fatty acids are the monomolecular films investigated by Langmuir and by Adam, and it would appear that in passing from one acid to a homologue of greater molecular weight, each addition in thickness of the ultimate flake is made in complete independence of the previous length, as if the only thing that mattered was the nature of the attachment of one carbon atom to the next. There is no influence of the ends upon the atoms in the middle. Again, we have the forces different at different parts of the atomic surface, as in the case of bismuth and its homologues, in which the atom is attached to three neighbours on one side by bonds differing from those which attach it to its three neighbours on the other.

With regard to the nature of these binding forces three types may be recognised. First, there is the effect set up by the sharing of a pair of electrons by two contiguous atoms, leading to strong and directed attachment. Next, there are actions of a different and generally weaker type manifested in the binding of molecule to molecule in a crystal. We may be sure that this type plays an important part in metals and alloys. Lastly, there are the pure electrostatical central actions. In the case of the polar crystal Born and Landé have made some progress in calculating the effect of this.

One well-known fact in crystal growth is that the faces have different rates of growth, indicating that there may be great differences in the ease with which molecules slip into their places. Into this the element of time may enter, because a molecule may come nearly into its right place and be held there sufficiently long to get settled in by thermal agitation or otherwise. We may suppose that the formation of the crystal begins correctly enough, but that errors of adjustment creep in until the surface becomes somewhat disordered, and the growth ceases because fresh molecules cannot find their proper places to slip into. Without a more detailed knowledge of the active forces localised at various points of atoms and molecules we cannot build up a complete theory of cohesion.

Dr. Rosenhain, who followed, dealt with the simple monatomic bodies—the metals—in which the development of strength and ductility is so pronounced. In his opinion it has now become possible to sketch certain principles from which a general theory of the nature of alloys may arise. The first is that the atoms of two metals in solid solution are built on a simple space lattice, the atoms of the solute metal taking the places of a corresponding number of atoms of the solvent metal, the lattice remaining essentially unaltered. The presence of a "stranger" atom produces a certain amount of distortion which is responsible for the changes in the hardness, strength, melting point, and other properties of the metal. The second principle is that the inter-atomic distance through which interatomic cohesion is appreciable is strictly limited. When increased by any means—thermal expansion, mechanical stress, or "stranger" atoms—a limit is soon reached when the lattice breaks down suddenly with the formation of another phase. On heating, such a change is simply melting; on straining, it is the breakdown of elastic behaviour; and on alloying, we have the limit of solid solubility resulting in the formation of crystals of a new type. In many metals cohesion phenomena are complicated by the occurrence of intra-crystalline slip, which results in plastic deformation under stress by the process of slip along certain planes within the crystal. At the surface of slip there must be a rapid exchange of partners without loss of continuity of bonding. It is interesting that the phenomenon is confined to metals crystallising in the two most symmetrical systems, in which, presumably, the distribution of atoms is sufficiently uniform to permit the passing on of bonds to take place.

The mechanism of ductility by means of slip is intimately connected with diffusion in solid crystals. In Dr. Rosenhain's opinion the process of diffusion of one metal into another, the structure of which is already that of closely packed lattices, may be due to movement or slip of atoms in rows, the requisite stress, which at high temperatures need not be great, being provided by the lattice distortion arising from a concentration of "stranger" atoms in a solid solution of non-uniform concentration. On this view ductile metals should allow diffusion far more readily than brittle. It is well known that brittle metals, like antimony and bismuth, show no appreciable diffusion until quite near the melting point. Moreover, it is known that nickel and copper—two very similar atoms—exhibit extremely slow diffusion as compared with zinc and copper. This fits with the above view and is at the same time not to be expected on the view that metallic diffusion is a kinetic phenomenon similar to that of liquids and gases. On the same principles, a crude picture of the constitution of an amorphous solid fitting the facts in a general way may also be formed.

With regard to the method of binding of two crystal lattice systems growing towards one another,

one is struck by the fact that the junction of crystal to crystal is not a region of weakness, but is in fact the strongest part of a crystal aggregate. Metals, when forcibly broken in the cold, normally break through the crystals and not along the junctions. There are a large number of experimental facts supporting the view that the gap between two adjacent lattices is bridged by a region of irregularly arranged atoms constituting a layer of amorphous material of excessive strength.

Finally, while in solid solutions we find that the interatomic distances, though varying a few per cent., are roughly constant, in well-defined intermetallic compounds the interatomic distances are sometimes greatly reduced. Thus, in aluminium, the distance is of the order of 4·3 Å.U., but in the compound $CuAl_2$, aluminium atoms are found with a centre distance of only 2·42 Å.U. In this case, therefore, the nature of the interatomic binding must be quite different, and this probably constitutes the real difference between a compound and a solid solution.

Dr. A. A. Griffith, who followed, pointed out that while at first sight the correlation of data on the breaking strengths of materials with the magnitude of cohesive forces derived by physical method should be comparatively simple, this is far from being the case. One reason for this is that the majority of structural metals are ductile, so that under ordinary stress systems, which almost invariably comprise shearing stresses, the primary failure of the specimen does not involve atomic separation at all but is a failure in shear. Now the mode of collapse of a space-lattice in shear is a subject which has been studied very little by physicists, so that practically no information from the point of view of molecular cohesion is available to engineers.

In the case of certain materials, for example, glass, stone, and hard steel, which exhibit brittle fractures running perpendicular to the direction of the greatest tensile stress, some progress in the subject has been made. Calculations show that in such cases the observed tensile strength is only a small fraction of the calculated molecular tenacity. This discrepancy may be avoided if one assumes the existence of minute cracks in the material fracture being due to the very severe concentration of stress at the corners of the cracks. A formula may be developed which gives results of the right order of magnitude if the radius of the corners of the cracks is taken as two or three molecular spacings. There is another type of fracture obtained with brittle materials, namely, cracks running obliquely to the principal stresses, the best known case being the crushing fracture obtained by simple compression. This may be treated in a somewhat similar manner by the assumption of a large number of minute cracks oriented at random in the material.

With regard to the breakdown of ductile metals, Dr. Griffith and Mr. Lockspeiser have worked out a theory of plastic strain in which the conclusion is reached that plastic strain is simply the external manifestation of phase changes occurring within the material. This view in itself is not new, but the novelty arises from the fact that deductions are made regarding the number and nature of the distinct phases concerned in the action. The question arises whether it is likely on physical grounds that phase changes can occur as a result of the application of a shear stress; given that this is so, the evidence is more in favour of a resultant change in relative orientation of the atoms than of their configuration.

Prof. Lindemann considered that the assumption made by previous speakers that atoms or molecules are either bonded together, or not bonded, is premature, and cited the fact that fairly definite evidence for intramolecular attraction without definite bonds is to be found in the Sutherland correction to the temperature coefficient of the viscosity of gases, derived by assuming mutual attraction of molecules and verified experimentally.

Prof. R. W. Wood mentioned an interesting experiment requiring explanation. A crystal of rock salt placed in hot water can be immediately bent by the fingers, and remains deformed when removed from the water. The range of temperature over which this has been observed is small and the phenomenon does not occur in the case of immersion in hot oil.

To sum up, the discussion brought out clearly the fact that we are still only at the beginning of a complete explanation of the general phenomena, and there was point in the somewhat facetious remark of Sir Oliver Lodge that it was an extraordinary fact that, after all these years, three important sections of the British Association should be gathered together to discuss why, when one end of a stick is raised from a table, the rest of it also comes up.

Paris Meeting of the International Council for the Exploration of the Sea.

THE sixteenth annual meeting of the International Council for the Exploration of the Sea was held in Paris, on the invitation of the French Government, on October 1–5. By the courtesy of the Administrative Council, accommodation was provided for the Council in the Institut Océanographique, founded by the late Prince Albert of Monaco. The following countries, members of the Council, were represented: Belgium, Denmark, Esthonia (for the first time), Finland, France, Great Britain, Holland, Norway, Portugal and Sweden. Representatives of the Irish Free State attended as visitors.

The usual committees and sections for hydrography, plankton, statistics, herring, plaice, cod and haddock, limnology, the Baltic Sea and the Atlantic Slope were assembled, and a new committee, named the North Atlantic Committee, was formed.

It is important to observe that all committees and sections are now instructed to formulate precise programmes of work, allotting to each country concerned a definite part in the programme, which it undertakes to perform. Each country is called upon afterwards to report to the Council on the work it has carried out in accordance with these undertakings, and the effect of these reports is embodied in a general progress report submitted to the Council at each meeting. The tendency to present excellent but unrealisable recommendations is thus discouraged.

For the most part the committees reaffirmed their existing programmes in respect of which generally satisfactory progress was reported. It will be observed that there are three committees for the study of particular fishes. The Plaice Committee, the recommendations of which for the protection of the plaice fisheries were adopted by the Council in 1922, and are now under the consideration of the participating Governments, is chiefly engaged in watching developments and checking its own conclusions.

The intensive investigations of the plaice having thus come to a pause, the study of the herring, cod and haddock is being vigorously prosecuted, in accordance with comprehensive practical programmes adopted in 1921, and afterwards modified in the light of experience. Unfortunately, owing to the difficulties of the time, many of the countries concerned are

inadequately equipped for work at sea, and the bulk of the sea work falls on England and Scotland. It is particularly regrettable that Norway, to which, in the person of Dr. Einar Lea, is entrusted the leadership of the herring investigations, has not yet been able again to equip a ship for deep-sea research. The herring investigations at their present stage involve, to a considerable extent, the application to the investigation of North Sea herrings of the methods employed by Hjort and Lea in their investigations of the Norwegian herrings. With a view to the standardisation of these methods, English and Scottish naturalists are studying under Hjort and Lea at Christiania.

The Cod and Haddock Committee is under the convenership of Dr. E. S. Russell; but the work of direction is divided between England and Scotland, the latter being responsible, through Dr. Bowman, for dealing with haddock material and the former with cod.

The proposal to form a North Atlantic Committee was approved after a lengthy debate in a special committee of the whole Council. On one hand it was felt that the committees were already dangerously numerous, that the fishes which would come under examination by the North Atlantic Committee were mainly those actually being investigated by other committees, and that a further extension of the principle of geographical division of work already accepted in the formation of the Committee of the Atlantic Slope and the Baltic Committee created the risk of redundancy unless it could be shown that the area to be studied was, in respect of some at least of its features, self-contained, and presented phenomena peculiar to itself. It was more particularly on the last-named ground that the Danish Commission in a memorandum submitted to the Council supported their proposal, which had for its principal object the study of the fisheries of Iceland and Faroe. They pointed out that the Icelandic fisheries in particular, and the physical conditions governing those fisheries, presented peculiarities which merited individual study. They summarised their argument in the following terms: "In regard to fishery biology as well as hydrography the various parts of the Icelandic area are extremely dissimilar. There is in fact a greater difference in this respect between South and East Iceland than between South Iceland and the Faroes, or, indeed, between South Iceland and Ireland."

The Council eventually resolved to form a North Atlantic Committee for research north of the latitude of Rockall, and, while instructing the Committee to commence work in the area suggested in the Danish Commission's memorandum, urged it to keep in mind the importance of extending its area of observations particularly to the eastern and northern parts of the Norwegian Sea. The Committee was further instructed to arrange its programme in consultation with the other committees concerned. The programme adopted, in accordance with this instruction, provides for the hydrographical and biological investigation of the region, with special reference to cod, haddock, halibut, plaice and herring. The leadership of the work was entrusted to Dr. Johs. Schmidt. The greater part of the sea work will be carried out by means of the *Dana*, but France will make provision for observations by means of cruisers stationed at Iceland, and Scotland will conduct hydrographical-biological cruises from the west of Scotland to the Faroes. England will assist with fishery statistics and measurements.

An interesting discussion arose in connexion with the work of the Statistical Committee, of which Prof. D'Arcy Thompson is permanent chairman. The British delegates were instructed to endeavour to secure the general adoption of more effective and, in particular, more uniform statistical methods, such as are in use in Great Britain. Owing to the lack of uniformity of method, it is at present most difficult to present in the Bulletin statistics which afford a true indication of the actual condition of the fisheries in a given region or part of a region, and of the variations of the stock from year to year. For example, different countries while using the same regional nomenclature have different conceptions of the limits of the regions, and the majority of them are not able to give any accurate idea of the precise locality fished or of the amount of fish of any given species—or of fish of all kinds—taken per unit of time; *e.g.*, the quantity of fish taken in a given area in 100 hours' fishing. Statistics which do not present a picture of the distribution of the stock in time and space are of little value to the scientific worker, and it is for scientific rather than for commercial purposes that the International Council should collect and publish statistics. It was readily agreed by the Statistical Committee that uniformity must be secured in the matter of the designation of statistical regions and areas; but it was impossible in the time at the disposal of the Committee to arrive at unanimity as to the limits by which the regions should be defined. This question was accordingly referred to a special sub-committee which was requested to report to the committee before the next meeting of the Council. The question of getting detailed statistics of locality of capture, *i.e.* fishing ground, and of the relation of fishing power to catch of fish, proved to be one of ways and means, and the reply of most countries was that they had not the staff for the collection of such statistics on the scale adopted in Great Britain. Eventually it was agreed that each country should endeavour to collect statistics from some of its vessels according to the methods employed in England, and an undertaking was given on behalf of the English Department, being the best equipped for the purpose, that the Department would for the present work up the data if sent to them.

The work of the Committee of the Atlantic Slope continues to be under the leadership of Dr. Edouard le Danois. The English Department is not yet in a position to take part in the sea work, but it is hoped that the Marine Biological Association will continue the assistance which it has given in the past.

A memorandum was submitted to the Council by Prof. Otto Pettersson and Commodore C. F. Drechsel advocating an international expedition to study the system of currents of the great oceans, with reference especially, to quote from the memorandum, to the following questions:

"(1) Whether the changes we observe in the fish life of our seas correspond with the changes we observe in the current system of the ocean; and

"(2) Whether these changes are of periodic nature."

The authors of the memorandum, which gave rise to a most interesting debate, urged that advantage should be taken of the fact that the late Prince of Monaco's yacht *Hirondelle* was for sale to secure and equip this vessel and to employ it for four years in an investigation of the questions above stated. They invited the Council to support the proposal, which they desired to submit, with the authority of the Council, to the governments of the civilised world, in the hope of securing the co-operation of all these governments in the enterprise. They pointed out that if the proposal secured world-wide support the actual cost to any individual country would be comparatively small. In the debate which took place

upon the memorandum it was freely recognised that the practical difficulties in the way of the realisation of such a scheme would be great. The Council, however, eventually passed a resolution recording its opinion that an increased knowledge of the ocean systems was not merely of scientific interest but of practical importance for the explanation and the forecasting of phenomena affecting life both in the sea and on land, that such an investigation must necessarily be extended over many years, but that it could usefully be initiated by a preliminary reconnaissance on the lines suggested in the memorandum. The Council therefore recommended the proposals to the favourable consideration of the governments and scientific institutions of all countries. In its resolution the Council was careful to point out that such an undertaking as this went far beyond the limits both of its resources and of its mandate, and must be regarded as a distinct and world-wide enterprise. It affirmed, however, its readiness, should the proposal meet with adequate support, to undertake the general direction of the work. It was generally felt that there was no other existing organisation equally competent.

The next meeting of the Council will be held, as usual, in Copenhagen.

Electrometric Methods in Analytical Chemistry.[1]

THIRTY years ago electrometric methods of analysis were too complex for technical purposes, but the importance of "hydrogen ion concentration" re-directed attention to them, with resulting simplification.

When a piece of silver is dipped in a solution, a solution pressure is exerted, silver ions being driven into solution until equilibrium is established between the osmotic pressure of the ions in the solution and the solution pressure of the silver. Hydrogen behaves similarly, as does chlorine. It thus becomes possible to find a suitable electrode for any reaction giving a change in valency.

In the reduction of potassium permanganate the electrolytic potential (ϵ) is given by the formula:

$$\epsilon = \epsilon_0 + \frac{0{\cdot}058}{n} \log \frac{[Mn'']}{[H]^8[MnO_4']}.$$

If the log expression is kept constant there results a normal electrode. In practice such an electrode must be combined with one which changes its potential during the course of the titration. It is possible to titrate silver with halides, sulphides, cyanides, and thiocyanates, and vice versa. An interesting feature is the possibility of the simultaneous titration of halides in admixture, there being successive falls of potential as each is reacted upon by the silver solution. In the presence of protective colloids there is of course no apparent precipitation. It is interesting to note that this does not interfere with the titration.

Protective colloids stop crystal growth and consequently increase somewhat the solubility of the precipitate. This solubility is usually so low that an increase of even 100 per cent. does not lead to appreciable errors. It thus becomes possible to estimate directly small amounts of metal in, say, blood serum. Certain organic substances, such as silver salvarsan, contain silver in such a form that it is not acted upon by chlorides. Use is made of sulphides, the diameters of the ions of which are such that monovalent cations of the dimensions of silver ions are unable to resist their influence. Ionic dimensions play an important part in determining the insolubility of certain precipitates.

Titrating zinc in acid solution with potassium ferrocyanide, curves not of the usual bi-logarithmic type are obtained. The abnormality is due to small amounts of ferric iron. On filtering through aluminium powder, reduction to ferrous iron takes place and normal curves are obtained.

For nickel and cobalt in admixture electrometric titration with potassium cyanide is the best. The complex ions $''Ni(CN)_4$ and $''Co(OH)(CN)_5$ are formed. The curves obtained yield no evidence of the formation of intermediate complexes.

For oxidation and reduction titrations a platinised electrode is most satisfactory. Titanium may be estimated very accurately in the presence of iron after filtration through a cadmium powder filter in an atmosphere of carbon dioxide and subsequent titration with potassium dichromate. If a blank electrode is employed it is liable to become passive at the end of the titration, producing a sudden drop of potential instead of a rise.

With regard to dye-stuffs there is little to add to the excellent methods of Knecht, but where electrometric methods are used, frequent use is made of cadmium filters for reduction. Titrating primary amines in acid solution with sodium nitrite a sudden rise in potential is obtained with the first drop in excess of the latter.

For the estimation of free halogens an example was given of the estimation of 0·1 per cent. of bromine in sodium chlorate by distillation with hydrochloric acid followed by titration with arsenious acid.

An especially resistant electrode for the estimation of insoluble oxides is obtained by passing an alloy of 90 per cent. gold with 10 per cent. copper through a bunsen flame, when it becomes covered with a thin layer of a copper oxide.

In conductivity titrations the conductivity usually changes sharply enough to indicate the end-point, but where weak acids are concerned care must be exercised. Use is made of a Wheatstone bridge and an alternating current. The millivoltmeter may still be used by the introduction of a rotating switch, the poles in the solution being changed six to eight times a second. The current then becomes virtually a continuous one. The method is the best one for alkaloids and also for water in organic liquids. An example of the latter is the estimation of water in so-called absolute alcohol. A salt is added which completely ionises in aqueous solution, *e.g.* potassium perchlorate. The alcohol is rapidly stirred and the conductivity measured. The solubility of the salt is a linear function of the water present, and from an examination of the curves obtained its content may be deduced. Conductivity methods are excellent for determining and comparing the hardness of waters.

The last few years has seen the replacement of electro-deposition methods by titration methods, and very accurate results may now be obtained even with the simplest equipment. The behaviour of titration electrodes requires further study, and from the work now being carried out on surface adsorption and surface actions in general, much progress may be expected in the future.

L. G. R.

[1] Synopsis of a paper presented to the Manchester Sections of the Society of Chemical Industry, Society of Dyers and Colourists, Institute of Chemistry, and the Manchester Literary and Philosophical Society, on November 2, by Prof. W. D. Treadwell of the Technical Highschool, Zürich.

University and Educational Intelligence.

CAMBRIDGE.—The Right Honourable S. M. Bruce has been elected an honorary fellow of Trinity Hall. Mr. P. J. Durrant, Corpus Christi College, has been elected fellow and lecturer in natural sciences at Selwyn College. Mr. R. H. Fowler, Trinity College, has been appointed University lecturer in mathematics.

The desk habitually used by Francis Maitland Balfour and afterwards by Sir Michael Foster—two of the chief founders of the Biological Schools of the University—has been presented by Dr. Michael Foster to the Balfour Library.

The Annual Report of the Special Board for Agriculture and Forestry shows a falling off in the number of students from the excessive numbers immediately after the War. Amongst the notable events in the year's working of the department are included the completion of the purchase of the University farm, the foundation of the professorship of animal pathology, the organisation of the Horticultural Research Station, and the addition of Poultry Sections to the Animal Nutrition Institute and the Genetics Institute.

Trinity College announces a research studentship open to graduates of Universities other than Cambridge, and also exhibitions open to students at present studying at Dominion or Colonial Universities.

DURHAM.—The Newcastle and Gateshead Water Company have granted the sum of 100*l*. to Mr. B. Millard Griffiths, lecturer in botany at Armstrong College, Newcastle-upon-Tyne, to enable him to carry out further researches on the micro-flora (phytoplankton) and the hydrography of the smaller bodies of fresh water.

EDINBURGH.—On November 12, the Right Hon. William Lyon Mackenzie King, Prime Minister of Canada, and the Hon. William Robertson Warren, Prime Minister of Newfoundland, received the honorary degree of LL.D. At the close of the ceremony, Mr. Mackenzie King delivered a short address on the Imperial Conference, which, he said, had proceeded on sound constitutional lines that would be enduring in the development of the political evolution of the British Empire.

LIVERPOOL.—The late Mr. William Prescott has bequeathed 20,000*l*. to the University to found a chair of agriculture or a chair for the furtherance of one or more of the following subjects, namely, the chemistry of agriculture, the cultivation of land, the care, breeding and raising of crops, the diseases of crops, or any other subject connected with agriculture. The University is given twelve months in which to decide whether or not it can accept this gift.

Mr. William Horton has been appointed honorary lecturer in plant histology.

MANCHESTER.—Prof. A. V. Hill has presented a sum of 200*l*. to endow a prize to be awarded for an essay on a biochemical subject.

Mr. Edgar Morton has been appointed assistant lecturer in economic geology.

The following have been elected to honorary research fellowships: Dr. E. D'Arcy McCrea, in physiology; Mrs. Gertrude Robinson, in chemistry; Mr. W. K. Slater, in chemical physiology.

THE Universities of Brussels and Montreal both report gifts of radium among their benefactions during 1922–23. The former participates in a gift of 8 gm. by a mining company to the universities of Belgium, and the latter has been entrusted by the Government of the Province of Quebec with $1\frac{1}{4}$ gm.

ACCORDING to the *British Medical Journal*, honorary degrees will be conferred on November 24 by the University of Paris on the following distinguished men of science: Sir J. J. Thomson; Prof. Camillo Golgi, emeritus professor in the University of Pavia; Dr. W. W. Keen, formerly professor of surgery in the Jefferson College, Philadelphia, and Prof. S. A. Arrhenius, of Stockholm.

A CLARENCE GRAFF fellowship, tenable for one year by a British graduate of Oxford or Cambridge at any American university located between the Allegheny and Rocky Mountains, has been founded by Mr. Graff, an American banker resident in London. The object of establishing the fellowship, which carries a stipend of 250*l*. plus tuition fees, is "to foster a better understanding in Great Britain of social conditions and currents of opinion in the United States of America." The award will be made by a committee consisting of the secretary of the Universities' Bureau of the British Empire, the director and assistant director of the American University Union in Europe, and the vice-chancellors of the Universities of Oxford and Cambridge, and preference will be given to a student of humanitarian studies. Earlier this year (May 5, p. 621) we referred to the foundation of Henry P. Davison scholarships at American universities for Oxford and Cambridge men, and it is noteworthy that in each case the gifts have come from Americans. They will help to swell the very small number of awards at American universities available to British students compared with the 96 Rhodes scholarships at Oxford for Americans.

PARTY politics have no place in the columns of NATURE, but we are concerned with what is promised or performed by our statesmen or politicians on behalf of scientific progress. We are, therefore, interested in the election address which Mr. H. G. Wells, as Labour candidate for the University of London constituency, has issued, together with a report of a speech on "Socialism and the Scientific Motive." The Labour Party believes, he says, in science and in the scientific motive as a motive altogether superior to profit-seeking. He appeals to university people as people who know something of the work of scientific investigators, artists, men of letters, teachers, and medical men; who know that none of these work for profit or on the profiteering system, but for service, and that the work they do is infinitely better and more devoted than the work that men do for the profit-making motive. This knowledge should enable them to see that if, in accordance with the doctrines of Labour Party Socialism, collective ownership were to replace private ownership in nearly all the common interests and services of the community, these things would be better managed, especially as the Labour Party recognises "the supreme need of scientific knowledge and the necessary leadership of professionally trained men . . . and teachers." The argument is not altogether convincing, but Mr. Wells is at any rate capable of the philosophic point of view, and if he controlled the policy of the Labour Party, universities would not need to fear inconsiderate treatment at the hands of a Labour Government. One wonders, however, how far his attitude would be likely to be adopted by the people who would determine the policy of such a government. Some of the remarks by Labour members in the House of Commons debate on the Oxford and Cambridge Universities Bill were the reverse of reassuring on this point.

Societies and Academies.

LONDON.

Royal Society, November 15.—Sir William **Bragg** and G. T. **Morgan**: Crystal structure and chemical constitution of basic beryllium acetate and propionate. Basic beryllium acetate is shown by X-ray analysis to be a highly co-ordinated compound. The molecule is a perfect tetrahedron, having an oxygen at the centre, a beryllium alone at each corner, and an acetyl group associated with each edge. The crystalline structure is the same as that of diamond. The propionate forms a monoclinic crystal. The propyl group can no longer be arranged so as to possess a plane of symmetry, as in the case of the acetyl; and in consequence the symmetry is much less.—G. I. **Taylor**: Experiments on the motion of solid bodies in rotating fluids.—L. C. **Jackson**: Investigations on paramagnetism at low temperatures. Pt. I. Powdered substances. The following paramagnetic substances have been investigated from atmospheric temperature down to the lowest temperature obtainable with liquid hydrogen (about 14° K): anhydrous sulphates, heptahydrated sulphates and ammonium double sulphates of cobalt, nickel, and ferrous iron. These substances follow the Weiss law $\chi(T+\Delta)=C$ at relatively high temperatures, but at the lowest temperatures, (1) susceptibility increases more rapidly with fall in temperature than is given by Weiss law, and (2) the curve of $1/x$ against T possesses a point of inflection; a maximum and a minimum value of susceptibility occur in the region of lowest temperatures. Pt. II. Crystals. The principal susceptibilities of crystals of cobalt ammonium sulphate and nickel sulphate (heptahydrate) have been determined over a temperature range of 290° K down to 14° K. The Curie constant C is same for each of the principal susceptibilities of any crystal. Deviations from the Weiss law in the case of cobalt ammonium sulphate fall into category (1) above, while those of nickel sulphate fall into category (2).—L. C. **Jackson** and H. Kamerlingh **Onnes**: The magnetic properties of some paramagnetic double sulphates at low temperatures. The magnetic susceptibilities of powdered cobalt potassium sulphate, cobalt rubidium sulphate, manganese ammonium sulphate, have been measured at temperatures from atmospheric temperature down to about 14° K. The two cobalt compounds confirm the results given above for cobalt ammonium sulphate. Manganese ammonium sulphate obeys the Curie law, $\chi T=$const., down to the lowest temperature investigated. This result fits well with the known behaviour of other manganese salts, showing that in this series of compounds the substance follows Curie's law more closely the greater its "magnetic dilution."—H. H. **Potter**: Some experiments on the proportionality of mass and weight. The gravitational accelerations of lead, steel, ammonium fluoride, bismuth, paraffin wax, duralumin, and mahogany have been compared with that of brass, and no difference greater than that attributable to experimental error has been found. An accuracy of one part in 50,000 has been obtained. Special attention has been given to two substances, ammonium fluoride and paraffin wax, which have large hydrogen contents.—Lord **Rayleigh**: Further studies on the glow of phosphorus and its extinction by moist oxygen. The velocity of blast necessary to blow away the glow of phosphorus increases enormously with rise of temperature. On the other hand it is enormously diminished by enriching the air blast with oxygen. In either case the range examined was of order 1000 times. This velocity of blast measures rate of propagation upstream of glow through mixture of phosphorus vapour and oxygen. Where the velocity is reduced, by cooling or by adding oxygen, to less than 1 cm./sec., the condition of extinction is approached. From this viewpoint the known extinction by moist oxygen alone is the limiting case of slow propagation. Hence extinction is due to failure of the process causing propagation, probably a catalytic action of products of combustion. Excess oxygen, like other inhibiting substances, "poisons" these products.—H. A. **Wilson**: An experiment on the origin of the earth's magnetic field.—H. **Robinson**: The secondary corpuscular rays produced by homogeneous X-rays. The Robinson-Rawlinson method of investigating velocities of secondary cathode rays produced by X-rays has been developed with the view of increased accuracy. Special attention has been paid to homogeneity of the primary X-ray beam. The velocities of secondary electrons are measured by deflexion in the magnetic field of a pair of large Helmholtz coils. The copper K_a rays are used as primary X-radiation. Five of the N absorption edges of bismuth have been measured, the remaining two not being separated from the O rings. All five M edges have been measured for atoms as light as tungsten. The L limits have been measured as far as copper, and the K limits to oxygen. Progressive changes occur along the series of elements in the relative intensities of different members of the same group.—J. W. **Gifford**, with an introduction by T. M. **Lowry**: Some refractive indices of benzene and cyclohexane.—J. A. V. **Butler**: A note on the significance of the electrode potential. A thermodynamical argument given in Heyrovsky's paper on the significance of the electrode potential contains stages of the cyclic process employed which are irreversible; hence the conclusions are erroneous. When the cyclic process is conducted reversibly, the sum of the differences of potential round the cycle is zero; therefore no information regarding the relations between the electrode potentials and the various chemical equilibrium constants is obtained by the use of a cyclic process of this kind.

Mineralogical Society, November 6 (Anniversary meeting).—Dr. A. Hutchinson president, in the chair.—L. J. **Spencer**: Euclase and platinum from diamond-washings in British Guiana. Small disks resembling fossil corals consist of a radial aggregation of euclase crystals so arranged that the plane of symmetry is always parallel to the surface of the disk. These, together with tourmaline, diamond, gold, and platinum, were found in the conglomerates near the Kaieteur Falls on the Potaro River. Platinum has not hitherto been recorded from British Guiana.—H. E. **Buckley**: Some anomalous optical properties of freshly-prepared mixed crystals of the Seignette salts. In the orthorhombic and isomorphous Seignette salts the sodium-potassium tartrate has the optic axial plane parallel to the brachy-pinacoid, whilst in the sodium-ammonium salt it is parallel to the macropinacoid. Mixed crystals of the two salts show, as would be expected, the optic axes for different colours in two planes at right angles (as in brookite), but only after the crystals have been prepared for some time. Freshly-prepared mixed crystals exhibit crossed dispersion of the monoclinic type (as in borax). A maximum angle of 75° between the axial planes for red and violet light is given by crystals containing 45 per cent. sodium-potassium tartrate. On standing, the axial planes slowly migrate to the planes of symmetry, and equilibrium is established in from two to thirteen weeks, this

being hastened by increasing the temperature.—N. T. **Belaiew**: On the genesis of Widmanstätten structure in meteorites and in terrestrial alloys. The Widmanstätten structure belongs to the triad of secondary structures, the other two being the structure of large crystals and the network structure. Under suitable conditions either of these structures may occur in iron-carbon alloys or in any other alloys crystallising in the face-centred cubic lattice and exhibiting the same kind of equilibrium diagram. As the diagram of the iron-nickel alloys is quite similar to that of iron-carbon, the same kind of crystallisation may be expected in both cases and also in meteorites. The well-known Widmanstätten figures in meteorites are also arranged in a Widmanstätten structure, and the conditions to which they owe their appearance are a very slow cooling after solidification in the granulation zone and a relatively rapid separation of the constituents afterwards in the zone of secondary crystallisation leading to their lodging themselves parallel to the octahedral planes in every granula.—L. R. **Wilberforce**: Illustration and detection of inclined and horizontal dispersion in bi-axial crystals. If the optic picture of an ordinary bi-axial crystal is viewed through a prism the refracting edge of which is parallel or perpendicular to the axial plane, the appearances characteristic of horizontal and inclined dispersion respectively are produced. Such dispersions in a crystal, if too small to be detected by direct observation, can be discovered by thus using a prism of small angle alternately to reinforce and oppose them, and noting the want of symmetry in the effects produced. —A. **Russell**: On the occurrence of the rare mineral nadorite in Cornwall, and of beraunite (eleonorite) in Co. Cork, Ireland. A single specimen of the rare mineral nadorite was found at the small antimony mine Bodannon, St. Endellion, Cornwall. It forms aggregates of nearly square platy crystals, transparent, of a yellowish-brown to reddish-brown colour, occupying a cavity in fibrous jamesonite. The crystals are combinations of *a* (100) and *r* (130) and are twinned on *l* (011). A very well-defined specimen of the variety of beraunite known as eleonorite, found at the iron and manganese mine of Roury Glen, Glandore, Co. Cork, consists of a mass of diverging fibrous crystals of a reddish-brown colour, between walls of limonite. The fibres are elongated in the direction of the *b* axis and show very strong pleochroism.—A. F. **Hallimond** and F. R. **Ennos**: On stilpnomelane, from North Wales. A dark scaly vein-mineral, strongly resembling biotite, proves on analysis to contain very little potash, and is very similar in physical properties to stilpnomelane from Moravia. The composition appears to be $6SiO_2 \cdot 2Fe_2O_3 \cdot 2FeO \cdot 3H_2O$; sp.g. 2·85; apparently uniaxial; o = 1·687, e = 1·595; pleochroic, o = dark brown, e = pale yellow; brittle, with eminent basal cleavage and marked cleavage normal to this, yielding pleochroic chips; H = 3·5; insoluble in hot N/2 HCl. —G. T. **Prior**: On the chemical composition of the Ashdon meteorite: This meteoric stone which fell at Ashdon near Saffron Walden, Essex, on March 9, 1923, is a white hypersthene-chondrite containing 8¾ per cent. of nickeliferous iron in which the ratio of iron to nickel is about 6 to 1.

CAMBRIDGE.

Philosophical Society, October 29.—Mr. C. T. Heycock, president, in the chair.—W. J. **Harrison**: On the motion of spheres, circular and elliptic cylinders through viscous fluid.—E. A. **Milne**: On the derivation of the equations of transfer of radiation and their application to the interior of a star.—F. P. **White**: (1) The conics through fives of six points. (2) Certain nets of plane curves.—C. G. **Darwin** and R. H. **Fowler**: Some refinements of the theory of dissociation equilibria.—J. C. **Burkill**: The fundamental theorem of Denjoy integration.—D. R. **Hartree**: On the correction for non-uniformity of field in experiments on the magnetic deflexion of β-rays.—T. M. **Cherry**: On the solution of certain difference equations.—W. **Burnside**: On the formulæ of one-dimensional kinematics.—W. P. **Milne**: Note on the twelve points of intersection of a quadri-quadric curve with a cubic surface.—E. S. **Bieler**: The effect of deviations from the inverse square law on the scattering of α-particles.—W. M. H. **Greaves**: The stability of the periodic states of the triode oscillator.—D. **Keilin**: The structure and life-history of Lipotropha n.g., a new type of Schizogregarine, parasitic in the fat body of a dipterous larva (Systenus).

MANCHESTER.

Literary and Philosophical Society, November 6.—R. H. **Thouless**: The psycho-galvanic phenomenon. The psycho-galvanic phenomenon is the change which takes place in the bodily resistance during emotion. It may be measured by placing electrodes on the palm and back of the hand, and balancing the resistance so obtained in a Wheatstone bridge circuit. The threat to prick the subject with a pin may produce a reduction of more than 1000 ohms in a total resistance of 12,000 ohms. The exact physiological change producing this result is not known, but we are clearly measuring one of the many involuntary bodily changes which accompany emotion. One person may react much more readily than another. Possibly this may be due to differences in temperament or to such prosaic causes as differences in the dryness of the skin. Similarly, differences in the resistance changes of the same person on different days are as likely to be due to simple physiological changes as to differences in his mood. What may reasonably be assumed is that one person during the course of one sitting gives greater resistance changes for greater emotion and vice versa; though after a resistance change, there is a long period of slow recovery, and the extent of a new deflexion probably depends in part on what stage in recovery has been reached.

PARIS.

Academy of Sciences, October 29.—M. Albin Haller in the chair.—The president announced the death of M. Maurice Leblanc, member of the section for the application of Science to Industry.—J. **Costantin** and L. **Dufour**: A secondary disease of the oak caused by *Polyporus* (*Phellinus*) *rubriporus*. The growth of this fungus is very slow, attacking the tree always near the soil level. Details are given of thirty-two trees attacked by this disease. Owing to its slow growth and the fact that the fungus can enter the tree only at a damaged spot, the disease is unlikely to prove troublesome.—Viggo **Brun**: The direct study of Riemann's $f(x)$.—A. **Guillet**: The mechanical determination of the relative course of two pendulums. A comparator with a chronometric motor.—A. **Damiens**: The dynamic allotropy of mercuric iodide. The author has repeated some recent experiments of Smits and Bokhorst on the change of the red into the yellow varieties of mercuric iodide. While the experimental results agree, under certain conditions, the author's interpretation differs entirely from that of the above workers. The necessity for a new theory of allotropy

does not appear to be proved, and the characteristics presented by the allotropy of mercuric iodide can be readily explained by the usually accepted theory.—René **Audubert**: The action of light on metal electrodes with small solution pressures.—André **Graire**: The estimation of sulphonitric and sulphonitrous acids. None of the methods of analysis of commercial products in general use gives satisfactory results. The author gives a preference to the Schloesing method with ferrous chloride.—M. **Bourguel**: The action of sodium amide on the chlorides derived from an aldehyde or a ketone by the use of phosphorus pentachloride. Sodium amide is a more satisfactory reagent for the removal of hydrochloric acid from these chlorine compounds than dry potash or alcoholic potash. The yields are higher and the products purer.—V. **Crémieu**: The variation in the composition of gases spontaneously evolved from thermal springs produced by earthquakes.—V. **Agafonoff**: The limit of the accumulation of humus in soils, with reference to observations on soils of the Nièvre.—G. **Pontier**: The fossil elephants of England: the mammoth in England and in the North Sea.—V. **Lubimenko** and Mme. S. **Fichtenholz**: Contribution to the study of the physiological rôle of the nervation of leaves. The main function of the nervation of the leaf is the mechanical support of the limb. The transport of water is only a minor function.—E. **Aubel** and R. **Wurmser**: The formation of glucose at the expense of alanine and of lactic and pyruvic acids. Experiments on dogs proved that 92 per cent. of alanine and lactic acid are transformed by the animal into glucose, but that in the most favourable case only 80 per cent. of the pyruvic acid underwent this transformation.—A. **Quidor** and Marcel A. **Hérubel**: The psycho-physiology of the visual phenomena in animals.—H. **Barthélémy**: The impregnation of the uterine eggs of *Rana fusca* and of *Bufo vulgaris* after immersion in water or in aqueous solutions of common salt.—J. **Bridré** and A. **Donatien**: The micro-organism of contagious agalaxy and its culture *in vitro*. Cultures of this organism have been made in tubes, details of the technique followed being given. The activity of the cultures was proved by experiments on sheep and goats. The organism was visible after staining by the slow method of Giemsa, after fixing the colour (May-Grünwald).—MM. **Brocq-Rousseau**, **Forgeot**, and **Urbain**: Serotherapy against glanders in the horse.

Official Publications Received.

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the Year 1922. By G. W. Paget. Pp. vi+49. (Cairo: Government Publications Office.) P.T. 5.

University College of North Wales. Calendar for Sessions 1922–23 and 1923–24. Pp. 425. (Bangor.)

Diary of Societies.

MONDAY, November 26.

Faraday Society (at Institution of Electrical Engineers), at 3.—General Discussion on Electrode Reactions and Equilibria. Part I. Conditions of Equilibrium at Reversible Electrodes.—Dr. E. K. Rideal: Introductory Address—The Mechanism of the Reversible Electrode.—Prof. E. Biilmann: Oxidation and Reduction Potentials of Organic Compounds.—Dr. J. Heyrovsky: The Process at the Mercury-dropping Cathode. Part I. The Deposition of Metals.—Prof. A. W. Porter: Note on the Standardisation of the Sign of the Potential.—Dr. J. N. Pring: The Determination of Affinity Constants by the Hydrogen and Quinhydrone Electrodes.—Prof. E. Baur: Electrode-Potentials on Non-Aqueous Solutions.—M. Shikata: Concentration Cells and Electrolysis of Sodium Ethoxide Solutions.—J. A. V. Butler: Studies in Heterogeneous Equilibrium. Part II. The Kinetic Interpretation of the Nernst Theory of E.M.F. Part III. A Kinetic Theory of Reversible Oxidation Potentials at Inert Electrodes.—At 5.30.—Part II. Irreversible Electrode Phenomena.—Prof. A. J. Allmand and H. J. T. Ellingham: Introductory Address.—Prof. A. Smits: Electromotive Equilibrium and Polarisation.—N. V. S. Knibbs: The Gas Film Theory of Overvoltage.—U. R. Evans: The Influence of Obstructive Films in Anodic Processes.

Institute of Actuaries, at 5.—J. M. Laing: Notes on the Industrial Assurance Act, 1913.

Royal Sanitary Institute, at 5.—Miss M. A. Payne: Sanitary Relief Work in Russia.

Aristotelian Society (at University of London Club), at 8.—Prof. J. W. Scott: Some Reflections on the Incidence of Mathematics: Physical Speculation in Philosophy.

Royal Society of Medicine (Odontology Section), at 8.—A. T. Pitts: (1) (?) Dermoid Cyst of Mandible; (2) Dentigerous Cyst apparently arising from a Supernumerary Tooth.—J. G. Turner and others: Discussion on Pyorrhœa, its Prevention and Treatment.

TUESDAY, November 27.

Royal Society of Arts (Dominions and Colonies Section), at 4.30.—Viscount Burnham: The West Indies.

Royal Society of Medicine, at 5.—General Meeting.

Institution of Automobile Engineers (at Institution of Mechanical Engineers), at 6.30.—Demonstration and Discussion of Ignition Systems.

Royal Photographic Society of Great Britain, at 7.—Dr. C. E. K. Mees: Chemistry and the Motion Picture.

Optical Society (at Imperial College of Science and Technology), at 8.—Dr. M. von Rohr: Contributions to the History of the Spectacle Trade from the Earliest Times to Thomas Young's Appearance (Thomas Young Oration).

Royal Anthropological Institute (Special Meeting) (at Royal Society), at 8.15.—Dr. E. H. Hunt: Hyderabad Cairn Burials and their Significance.

WEDNESDAY, November 28.

Royal Microscopical Society (Industrial Applications Section), at 7.—J. E. Barnard: Lecture Demonstration.—Dr. S. H. Browning: The Application of the Microscope to Industrial Diseases.—C. A. Newton: The Microscope in the Examination of Condensed Milk.

Royal Society of Arts, at 8.—Sir Henry J. Gauvain: The Effect of Sun, Sea, and Open Air in the Treatment of Disease.

British Psychological Society (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. M. D. Eder: The Sting of Death.

THURSDAY, November 29.

Institution of Mining Engineers (Annual General Meeting) (at Geological Society), at 10.30 a.m.—Prof. R. W. Dron: Hydraulic Stowage at the Dalzell and Broomside Collieries.—Prof. K. N. Moss: Some Effects of High Air-temperatures upon the Miner.—T. D. Jones: Strata Temperatures in South Wales, including Pembrokeshire.—G. Coles: The Specific Heat of Coal.—Sir William Ellis: The Position of Mechanical Engineering in Colliery Operations.

Medical Officers of Schools Association (at 11 Chandos Street, W.1), at 5.15.—Dr. H. Crichton Miller, Dr. H. C. Cameron, and others: Discussions on The Nervous Child.

Royal Aeronautical Society (at Royal Society of Arts), at 5.30.—Major R. H. Mayo: The Development of High-speed Aircraft.

Royal Society of Medicine (Balneology and Climatology Section), at 5.30.—Dr. C. W. Buckley and others: Discussion on Diuresis.

Physical Society of London and Institution of Electrical Engineers (at Institution of Electrical Engineers), at 5.30 and 8.—S. G. Brown, Capt. P. P. Eckersley, Prof. C. L. Fortescue, Prof. J. T. MacGregor-Morris, Prof. E. Mallett, L. C. Pocock, H. L. Porter, Prof. A. O. Rankine, E. K. Sandeman, and G. A. Sutherland: Discussion on Loud Speakers for Wireless and Other Purposes.

FRIDAY, November 30.

Royal Society, at 4.—Anniversary.

Institution of Mechanical Engineers, at 6.—Prof. A. L. Mellanby: Clyde Marine Oil-Engines.

Royal Photographic Society of Great Britain, at 7.—A. J. Bull: The Weald, its Scenery and Structure.

Junior Institution of Engineers, at 7.30.—S. C. Saunders: Notes on Design of Paraffin Motors.

SATURDAY, December 1.

Gilbert White Fellowship (at 6 Queen Square, W.C.1), at 3.—F. R. S. Balfour: Trees and Flowers of the North-West Pacific Coast.

PUBLIC LECTURES.

SATURDAY, November 24.

Horniman Museum (Forest Hill), at 3.30.—Miss E. Goodyear: The Romance of the Highways.

TUESDAY, November 27.

King's College, at 5.30.—Miss Hilda D. Oakeley: The Roots of Early Greek Philosophy: Religious.

University College, at 5.30.—W. J. Perry: The Pan-Pacific Congress.

WEDNESDAY, November 28.

Royal Institute of Public Health, at 4.—Miss K. Platt: Problems in relation to Health in the Tropics.

THURSDAY, November 29.

London School of Economics, at 5.30.—G. N. Clark: Holland and Belgium and Europe (League of Nations Union Lecture).

University College, at 5.30.—Sir William J. Collins: The Life and Doctrine of Sir Edwin Chadwick.

SATURDAY, December 1.

Horniman Museum (Forest Hill), at 3.30.—H. N. Milligan: The Natural History of Dragons.

NATURE

SATURDAY, DECEMBER 1, 1923.

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Industrial Science.

THE appearance of the eighth annual report of the Department for Scientific and Industrial Research brings with it the reminder that time passes, and tells of much useful work performed. As usual, the report is divided into three sections: the report of the Committee of Council, the report of the Advisory Council of the Committee, and a summary of the work of the Research Boards and Committees of the Department with numerous appendices. The first section, in the main a formal résumé of the work done, records with apparent satisfaction a reduction of the estimates by some 20,000*l.*, a regrettable fact, in spite of the urgent need for economy, for wise expenditure in the application of science to present conditions might easily result in savings of far greater amount. After reference to the valuable work of the co-ordinating research boards established to connect the work of the scientific departments in the various services, both together and also with university and other scientific activities, the report directs attention to the fact that the Research Associations, supported out of the Million Fund, are approaching the end of the five years for which grants were made, and states the policy which, on the advice of the Advisory Council, has been adopted. "It must not be assumed," the report continues, "that further financial assistance will be recommended in every case. There will have to be ample proof that the industry is unable immediately to shoulder the entire responsibility, and further aid will only be given if the industry concerned is prepared to make a rapidly increasing effort towards complete responsibility."

Another direction in which the committee has taken an interesting step in its task of co-ordinating the scientific activities of the government departments is in the promotion of a joint exhibit at the British Empire Exhibition next year. After various consultations it has been agreed that there should be a central building in which the government departments concerned will arrange their exhibits, working in conjunction with a committee organised by the Department of Overseas Trade, while the Royal Society, financed by a grant from funds allocated by government, has assumed responsibility for an exhibit illustrating recent advances in pure science.

The report also records the fact that the French Government has established under the Minister of Public Instruction an *Office National des Recherches Scientifiques et Industrielles et des Inventions*, having objects much resembling those of the Department.

Turning now to the report of the Advisory Council, the ground covered is very extensive, the Research

Associations, the co-ordinating boards, the research boards, the National Physical Laboratory, the various other research institutions, and the organisation controlling grants to individual workers, are all passed in review. On the whole the record is one of continuous progress. Difficulties have been overcome and advances made in many directions. The Fuel Research Board has been weakened by the retirement of Sir George Beilby, who has for seven years guided its activities "and laid the foundations of a structure of new knowledge of great significance for the health and industrial welfare of this country." Dr. Lander succeeds him as director, while Sir Richard Threlfall becomes chairman of the Board. The gratifying fact is recorded that, at the International Conference on Radio-Telegraphy at Brussels last year, the programme of work prepared for the British delegates by the Radio Research Board found a ready acceptance as the basis of international research.

The appointment of Sir William Bragg to the Fullerian professorship at the Royal Institution is noted, and the arrangements by which he is to have the help of a staff of skilled assistants are referred to. Both he and the Advisory Council are to be congratulated on this; we may look forward to the Royal Institution and the Davy-Faraday Laboratory becoming the birthplace of a series of discoveries no less notable than those which have already made its name famous in the annals of science.

The committee which, in co-operation with the railway companies, has been set up under the chairmanship of Sir Alfred Ewing to investigate the stresses on railway bridges due to moving loads, has undertaken a difficult but important task. The weight and speed of trains have increased many fold since most of our bridges were built. Stress conditions are much more serious, the large factor of safety designed for is much reduced, and, while there may be no grounds for anticipating serious risks, investigation and fuller knowledge are urgently needed.

Growth of another kind is indicated by the purchase of land at Teddington for extensions of the National Physical Laboratory and other government institutions.

Only in one section is the note less assuring. After describing generally the scheme under which the Research Associations were established, the report of the Council continues: "The anticipations made at the inception have failed to be realised owing in large measure to industrial events since that date." The Associations were started during the last year of the War, four being founded before November 1918. It was hoped that they would be a flourishing product of the boom which was to follow and to last for five years at least. This hope has not been fulfilled; the boom lasted two years, during which period seventeen associations came into existence. Since 1920, a period of intense depression, only one has been added to the list. The five years for which the grants were made are now coming to an end; funds are running out. The Associations are financed from the Million Fund, and the question comes, What is to be done? Few if any really can stand alone; what is their record? Is it sufficiently promising to justify further State assistance even if it be possible to find the money? The Advisory Council has considered the facts, and, while realising that "the five years of grant appear likely to be insufficient in many cases to fulfil the original hopes of the scheme," has decided that there is no justification for continuing the original contracts. Existing agreements, therefore, are to be terminated at the end of the quinquennial period; should any association apply for a further grant, the case will be considered on its merits and an inquiry will be made into the circumstances. New grants may as the result of this be made, but in no case, it is held, should the grant extend for more than an additional five years.

The position is a difficult one; the circumstances of the past three years have been such that the scheme has not had a fair chance. What will the chances be in the next five years? The inquiries to be set on foot will throw some light on this question, and the plan proposed is probably the best that can be devised. But there are other difficulties, as the report points out. Scientific inquiry is coming to be recognised more and more as the basis on which advance in industry rests, while the calls of industry are no small inducement to science to advance. But co-operation in industrial investigation is novel. In Germany, in pre-War days, great firms could maintain their staffs of skilled workers; the same is possible in America now; but there are few concerns in England so large and so flourishing as to bear the expense of a private research laboratory. Such can probably be counted on the fingers of one hand; the Brown-Firth laboratories, the G.E.C. works at Wembley, and the laboratories of Barr and Stroud are well-known examples. Such firms do not participate in the work of the Associations; and among those who do the differences of position are very marked. By some the need of scientific inquiry is fully grasped: others have scarcely realised it. Some through long experience have gained a store of useful practical knowledge; why should they share it with others less happily placed? We give much, we gain little, they may not unnaturally say; wherein do we profit?

Yet we find that where there have been mutual trust and confidence; where each member of an Association

has been willing to give of his best, anxious to improve the common stock of knowledge and to profit by the new knowledge placed at his disposal by the research staff, the Association has prospered most; the firms which knew most have learnt more, and it has not been a question of giving everything, receiving nothing. Time only can solve the question. We may be allowed to hope that, as the welfare of its citizens depends on the prosperity of a State as a whole, so the advances of industrial science will benefit the whole industry, and not least those who by previous knowledge and experience are most able to profit it by them.

Popular Astronomy.

(1) *The Star People.* By Gaylord Johnson. Pp. xi + 107. (London: Methuen and Co., Ltd., n.d.) 4*s.* 6*d.* net.

(2) *The Vault of Heaven: An Introduction to Modern Astronomy.* By Sir Richard Gregory. Second edition, rewritten. Pp. vii + 202. (London: Methuen and Co., Ltd., 1923.) 6*s.* net.

(3) *The Heavens and their Story.* By Annie S. D. Maunder and E. Walter Maunder. Pp. 357. (London: The Epworth Press, n.d.) 4*s.* net.

(4) *The Kingdom of the Heavens: Some Star Secrets.* By Charles Nordmann. Translated by E. E. Fournier d'Albe. Pp. 262. (London: T. Fisher Unwin, Ltd., 1923.) 12*s.* 6*d.* net.

THE practically simultaneous appearance of four books, all written mainly with the object of making available the fundamental truths of astronomy, demonstrates alike the eagerness of the public to be informed and the willingness of those qualified by experience to minister to this praiseworthy curiosity. Naturally, there is much repetition; the same facts, or many of them, appear in each of the several volumes, but the method of presentation varies according to the assumed intelligence of those addressed.

(1) In the first, Mr. Gaylord Johnson addresses an audience of children and adopts kindergarten methods with the object of teaching them how to recognise and identify the constellations. The method is novel and, if it prove successful, we imagine that the ability of the teacher, the gift of creating interest in what is unfamiliar, the power of rapidly comprehending the direction of a child's thoughts, and the art of giving it expression will play as great a part as the ingenuity exhibited by the author of the scheme. Mr. Johnson's book may act as a stimulant, but against one danger we may utter a word of warning—the attempt to recollect too many stars and their delineations. This is an error into which we think the author has fallen. Many of the stars depicted are too faint, some of the fourth and lower magnitudes being included. Such faint stars might be allowed in groups, as in the Pleiades, but for isolated stars it is doubtful whether any below the second should be included. But adherence to such a rule would have prevented the drawing of the outline of the constellation figures, and this feature is naturally relied upon to increase the interest of the children.

(2) A second edition of "The Vault of Heaven" has long been needed. This early work from Sir Richard Gregory has been a warm favourite with the writer of this notice, who has lent it to many students anxious to become acquainted with the plan of the solar system and the constructive machinery of the stellar universe. Whether from politeness or conviction, all have expressed approval, and it is to be hoped that another generation will find equal pleasure with the contents.

This new edition, written up to date, serves a further purpose to those who have read the earlier. They will learn what has been accomplished by the improvements in the construction of instruments, and the continuous application of these potent engines of research to the study of the heavens. Spectroscopy and photography have advanced by leaps and bounds in the interval, and much information that was hoped for, but seemed outside the reach of human effort, has become part of the general stock of knowledge. The drift of the stars through space, the dimensions of the whole stellar universe, the growth and decay of worlds, with much else that invited speculation, have become certainties, and a new set of problems lies before the astronomers of the future, though it must be admitted some of the older and apparently simpler problems still stand tantalisingly on the border-land of the unknown, and individual judgment may interpret the evidence as temperament dictates. Among these may be placed the "canals" of Mars and the theories built on them, the varying appearances on the lunar surface, which Prof. W. H. Pickering and others have noted to recur with a regularity that betokens a cosmic cause. Concerning the correct interpretation of the observations, Sir Richard Gregory preserves a judicial attitude, presenting the evidence impartially, and leaving the verdict to the decision of instructed opinion. The class for whom the book is intended is clearly indicated, and this class should benefit from the well-arranged and accurate contents.

(3) We confess that we have read this book with no small measure of surprise, for it is apparently put forward as a recent compilation. It bears no date, and there is no suggestion that it is a reprint of an ancient work. But such well-informed authors could not, if the work were new, refer in the preface to the late Sir W. H. M. Christie as the Astronomer Royal, and afterwards

in the text discuss the possibility of Halley's comet being seen at its return in 1910, so that we can only conclude that it is not new. The book is intended for those who are unacquainted with astronomy, and in the early chapters is traced the method by which the ancients, unassisted by telescopes or measuring apparatus, may have gleaned their notions of astronomy. The plan is not original, but is well thought out, and suggests one of the most desirable methods of obtaining an insight into the geometry of the earth's surface. Later, the sun and planets are described as they are seen in a telescope, and the plan becomes that of ordinary descriptive astronomy. One of the authors is chiefly responsible for the discussion of the influence of sun-spots on the earth's magnetism, but we do not find the argument convincing, and additional facts have been brought to light that are not mentioned. In the concluding section reference is made to the stellar universe, but the more recent facts connected with its structure and dimensions are necessarily excluded.

(4) When so many authors are eager to put the facts of descriptive astronomy before an English public, there does not seem room for a translation. But Dr. Nordmann's work deserves a welcome reception, for it differs in some essential points from the ordinary popular treatise. His object, he tells us, is "to relate some of the marvels which the heavens have revealed to us lately. I shall speak not to instruct or amuse, but to produce thoughts, and even dreams, if I can." He bids us to expect neither the commonplaces of numerical detail nor the inane vapourings evoked by the study of the skies. Nevertheless, we are allowed to study the sun, though the magnetic and electric influences it exerts are insisted upon more than the grosser and obvious service of a centre of attraction, or the dispenser of light and heat. Similarly, the question of the habitability of the planets acquires more interest than the puzzling red spot on Jupiter, or the canals of Mars, which latter are distinctly pronounced a mirage. Thence we proceed to the stars, and are taught how to measure the distance that separates them from us. A most instructive study, clear and logical, is given of the theories of star drift, of island universes, giant and dwarf stars, and the general views that obtain of the stellar cosmos. But our author must indulge in a final paradox. He finds it in the rotation of the earth. He furnishes a dozen "proofs" that the earth turns on its axis and fearlessly faces the consequences of accumulation. The conclusion drawn is: that the earth turns and the earth does not turn are, kinematically speaking, equally true. "It is simply more convenient to suppose that the earth turns." But these be difficulties that cannot be explained in a small space.

Oceanography.

Founders of Oceanography and their Work: an Introduction to the Science of the Sea. By Sir William A. Herdman. Pp. xii + 340 + 29 plates. (London: E. Arnold and Co., 1923.) 21*s*. net.

AT the meeting of the British Association in Liverpool last September, it was mentioned that a new book on oceanography, by Sir William Herdman, had just been published. To the circle of marine workers this was something of an event, and now that the volume is before us we see that our anticipations concerning it are realised in full. In the preface—a section eminently worthy of attention in itself, and by no means to be skipped—we are informed that the book is based upon a course of about twenty public lectures given in 1919-20, while Sir William held, for the first year, the newly established chair of oceanography at the University of Liverpool. This at once explains the structure of the book and the arrangement of the subject matter, which differs from that of the ordinary text-book. The author's opening words are, "This is not a text-book of Oceanography," and he proceeds to express his doubts as to whether the time is yet come in oceanography to write "the comprehensive text-book drawing conclusions from various branches of science—ranging from astronomy to biology." In this the author is probably right, quite apart from the fact that there is scarcely a man at the moment who could do it satisfactorily.

Sir William Herdman's book may best be characterised as a series of oceanographical essays, more or less independent one of another, and dealing with persons and themes, for the most part those in which the author is himself specially interested, or in regard to which he possesses first-hand knowledge.

The book contains seventeen chapters and an appendix. Of these, the first six or seven are devoted to some of the leading lights of oceanography, their life and work, especially Edward Forbes, Wyville Thomson, John Murray, Alexander Agassiz, Prince Albert of Monaco, and Dr. Anton Dohrn. The last ten chapters deal with various oceanographical subjects, namely, hydrography, ocean currents (the Gulf Stream), submarine deposits, coral reefs and islands, luminescence in the sea, plankton—its nature, investigation, variations, and problems—applied oceanography, the sea-fisheries, and food-matters in the sea.

In these many and diverse fields the author proves himself an admirable guide—one who understands the art of making the subject interesting to his readers. The book is one of great freshness and charm, much of which is due to the impress of the author's personality; it bears throughout the mark of his own keen interest

in the science to which his life has been so zealously devoted. As a consequence, the book is never dull, even when treating of somewhat more recondite themes, and in many parts the presentment attains a degree of interest positively absorbing. Moreover, the treatment of the subject matter is sober and objective, as indeed one has a right to expect from an authority of so much knowledge and experience. We are struck not only by the author's enthusiasm for the problems themselves and for their extensive scope, but also by his practical recognition of their limitations; we feel safe in his guidance, because we feel he has the faculty of estimating values, of discriminating between the essential and the unessential. The author never attempts to conceal the limitations of our present knowledge; but he believes in the great future of oceanography, in the wealth of stimulating discovery which the science, still in its youth, has yet in store for mankind; and he contrives to inspire his readers with the same faith. But, like the practical man he is, he sees also that oceanography has other and more direct tasks before it in the service of humanity. He realises that it is this and this alone which can help us to exploit—or husband—the treasures of the sea better than we are able to do at present; that oceanography, as he aptly puts it, will help man in the future to become "less of a hunter, and more of a farmer of the sea."

The author has had the good fortune to come into personal contact with some of the greatest oceanographers; and he tells of them, giving his impression of their personalities in a most attractive manner. We are led to realise how much the influence of these men, especially Sir Wyville Thomson and Sir John Murray, meant to the author himself, and we should be grateful that he has not consigned his impressions to oblivion, but enabled younger generations of oceanographers to partake, as it were, in some degree in the life and happenings of the days when modern marine research was first created.

It is out of the question here to enter upon any detailed appreciation of the individual sections of Sir William Herdman's book; but if any parts should be noted as particularly valuable, they are chapters like the two on Wyville Thomson and John Murray, and the three on plankton and food-matters in the sea; the hydrographical sections, on the other hand, scarcely come up to the same level. For the rest, adverse criticism must be directed not so much towards what the book contains as to what it does not.

There are not a few writers who regard oceanography as being merely the study of physical and chemical conditions in the sea. Sir William Herdman is not one of these. To him, the biology of the sea is as much oceanography as are its physics, chemistry, and geology. I am entirely of the same opinion. On the other hand, I cannot but feel that hydrography has here been rather left out in the cold. Two chapters (viii. and ix.) out of seventeen, and 37 pages out of 329. This seems rather scant measure, even for those more interested in the biological side, and even granting that hydrographical observations occur here and there in the other chapters.[1] Also, the extensive work which has been carried out during the last thirty years by national and international investigations of the sea, in procuring information as to the food fishes, their development and life-histories, might, I think, have been found deserving of fuller and more particular treatment. The same applies to several institutions the principal task of which consists in working at the practical application of oceanography; in a book strongly emphasising the importance of this side of the work, they might have deserved special mention, whether for their particular organisation, or as having been of fundamental value to the methods of applied oceanography.

Nevertheless, though we might thus have wished for more, the author gives us, even without it, very much indeed, and there is every reason to congratulate him on the publication of this book. It is generally known that Sir William Herdman has furthered the advance of oceanography in his own country. In this book, he has not only set up a handsome monument to himself, but also—and this will doubtless please him more—has proved himself an excellent advocate for his young science of oceanography, both within and beyond the boundaries of Great Britain. JOHS. SCHMIDT.

Preventive Medicine.

An Introduction to the Practice of Preventive Medicine. By Prof. J. G. FitzGerald, assisted by Prof. Peter Gillespie and H. M. Lancaster. Pp. xx+826. (London: Henry Kimpton, 1923.) 37*s.* 6*d.* net.

THIS is the first "full-dress" Canadian text-book of preventive medicine, so far as we know, which has seen the light; and it is a happy augury of the future of public health in our sister country that so complete a book founded largely on Ontario experience should be practicable.

Dr. FitzGerald, the professor of hygiene and preventive medicine in the University of Toronto, has, with the assistance of several collaborators, focussed a vast mass of important information bearing on preventive medicine and public health, from which British

[1] Apropos of hydrography—one pious wish from a non-British reader: that one could but have those Fahrenheit degrees converted into Centigrade in all oceanographical works, British included. British workers seem to be able to reckon equally well with either—in the present work, for example, the temperatures are noted in Fahrenheit in one place, in Centigrade in another; but to the rest of us, Fahrenheit is an enormous disadvantage. I hope this heartfelt cry may find its way to British ears and hearts.

hygienists may gather many useful suggestions for improved practice.

Preventive medicine as the subject of a text-book is a title possessing some ambiguity, and one looks to the chapter headings and sub-headings to ascertain in what sense the words are used. In actual fact the contents of the words are very nearly identical with what in England is known as hygiene and public health, though this was scarcely to be anticipated. Public health more generally means that part of applied hygiene which has been introduced into the administrative machinery of our central and public-health authorities, while hygiene, although almost synonymous with preventive medicine, in most books on the subject has a more limited connotation.

The fact that a book on hygiene and public health should be called "An Introduction to the Practice of Preventive Medicine" is evidence of the expanding scope of public-health activities, which are increasingly embracing every phase and age of life. This beneficent intrusion of medicine—on its preventive side—is the subject of Prof. FitzGerald's suggestive first chapter, in which he forecasts the arrival of a time when it will no longer be said that "he was so sick he had to have a doctor," but when the physician will be engaged to keep his patient well, by supervision and advice. In view of this, extensive increases of our present services for safeguarding childbearing and childhood, and for periodical examinations at subsequent ages in life, are anticipated. The difference between insurance for medical purposes and prevention is aptly indicated in the words that the monetary and medical benefit may be used wisely or unwisely in the patient's *efforts to regain, not to maintain his health.*

Subsequent chapters deal with measures for the prevention of communicable diseases, each of some twenty or more diseases being discussed in some detail. Special space is given to the newly adopted measures for securing immunity against diphtheria by the administration of an antitoxin-toxin; and it would appear that by this means, guided by the Schick test, we have available a possibility of depriving diphtheria of all its power to kill and injure.

The chapter on tuberculosis contains much valuable information, but the statistics are not very skilfully presented. The essential point is pressed home that success cannot attend anti-tuberculosis efforts unless private physicians take an active part in the campaign, and constitute themselves leaders in the effort to protect human beings against excessive dosage of infection, whether from consumptives or from infected cows' milk.

The preventive aspects of pneumonia, of cerebrospinal meningitis, and of acute poliomyelitis are stated; and although these diseases remain among the least controllable of communicable diseases, much useful guidance is given.

Under the heading of smallpox an interesting account is given of an outbreak in Ontario in 1920–21, comprising 5078 cases with only 24 deaths. The low case mortality in this outbreak is similar to that experienced in many parts of America; and cases of a similar type have occurred occasionally in England. In other parts—usually traceable to an Eastern source in Europe, or to a Mexican source in America—the ordinary severe type of smallpox has occurred. In both types of the disease there is evidence of the protective effect of vaccination. It would appear that the mild type—which usually breeds true—is a definite mutation of the disease.

The chapter on venereal diseases gives a useful summary of its subject. The author, while non-committal on self-medication as a prophylactic, strongly urges medical treatment to any patient at the earliest possible moment after exposure to infection.

Considerable space is devoted to disinfection. Current disinfection during the course of an attack of diphtheria or scarlet fever is recognised as important, and considerable detail is given as to terminal disinfection when an attack is over. For these diseases, however, it is now recognised that, given thorough domestic cleansing, terminal gaseous or liquid disinfection of rooms does not diminish the number of recurrences of infection. The part of the book dealing with general hygiene gives full information as to water supplies, milk, foods, diet, and domestic and community sanitation, on which no special comment is needed. We note, however, that while the importance of movement of air in making the air of a room hygienic is not disputed, it is also pointed out that in conditions of overcrowding active ventilating may increase the danger of infection, by increasing the striking distance of particulate infective material, whether as dust, or as spray derived from coughing, etc.

The chapter on vital statistics contains a few minor errors. In England and Wales the geometrical method of estimating inter-censal populations is no longer adopted. No attempt is made to assess the relative value of the various tests employed in determining the health conditions of a community. Special chapters deal with the subjects of maternal and infant mortality, school hygiene, public-health clinics, and industrial hygiene, but these do not call for special comment.

On p. 673 are given interesting particulars of the amount spent per capita per annum in the various American States on health administration. The "health appropriation" varies from 30·8 cents in Pennsylvania to 2·1 cents in Texas, these sums being divisible among the following subdivisions of the Public Health Department—Engineering, Communi-

cable Diseases, Laboratory, Vital Statistics, Child Hygiene, Venereal Diseases. This table is followed by a valuable table by Dr. Chapin giving the relative value or "marks" of different branches of public-health work. It will surprise some English administrators to find plumbing and nuisances credited with 20 marks out of a total of 1000, while control of nostrums is given 50 marks, educational measures 80, and anti-tuberculosis work 140. There is much to be said for this American apportionment of merit. A number of appendices give details as to industrial hygiene, the employment of children, form of report of an industrial nurse, the Workmen's Compensation Act, housing, etc.

The book can be recommended as containing a review of recent information on most branches of preventive medicine, which would be most difficult to obtain elsewhere, except by reference to many documents.

Our Bookshelf.

Les Phénomènes thermioniques. Par Eugène Bloch. (Recueil des Conférences-Rapports de Documentation sur la Physique. Vol. 4, 1re Série, Conférences 9, 10. Édité par la Société *Journal de Physique.*) Pp. 111. (Paris: Les Presses universitaires de France, 1923.) 10 francs.

ELECTRIC conductivity and other effects produced in the neighbourhood of hot bodies are generally called "thermionic" phenomena. The author gives an interesting and clear account of several of the laws in connexion with effects that have recently been discovered by O. W. Richardson and others. In spite of the great progress that has been made, there is no indication that this mine of research is approaching exhaustion. New practical applications are being continually found. Thermionic valves are now being made by hundreds of thousands for use in radio communication, radiography (X-ray work), and for rectifying alternating currents. Notwithstanding the great practical use that is made of thermionic phenomena, we are still far from seeing how they explain contact difference theories or thermo-electricity. In particular, the theory of thermionic emission in gases gives rise to great difficulties. We have still to explain many apparent experimental contradictions. The serious study of ionisation potentials and of resonance founded on thermionic emissions has barely begun. As time elapses the theoretical field becomes more complex, but the possibilities of valuable discoveries become greater.

The Outline of the World To-Day. Edited by Sir Harry Johnston and Dr. L. Haden Guest. (To be completed in about 24 fortnightly parts.) Part 1. Pp. 40. (London: George Newnes, Ltd., 1923.) 1s. 2d. net.

THERE should be a demand for a work of this nature, which aims at giving "a clear and definite impression of the immense variety of the life and romance, the natural beauties and treasures, of other lands." The first issue contains the greater part of the section dealing with France, and is copiously illustrated with well-chosen photographs, colour plates, and coloured maps by Bartholomew. The letterpress is vivid, accurate, and sufficiently critical to give it value, but there is little attempt to describe or explain the scenery, and the maps have the defect of showing no physical features. Some attention to physical geography would not be amiss. There is no indication of the arrangement of the work except that it will "concentrate on the interesting side of nations and their lives, dealing with mankind at home . . . their joys and pleasures, their sports, their pageants, and their ideals." The authors of the various articles are not stated, but the names of the editors are sufficient guarantee that high authorities will be chosen. So far as can be judged from the first number, the work should prove of value in spreading a knowledge of the ways of other nations and encouraging an understanding of their ideals and ambitions.

The Banyankole: the Second Part of the Report of the Mackie Ethnological Expedition to Central Africa. By the Rev. John Roscoe. Pp. xii+176+31 plates. (Cambridge: At the University Press, 1923.) 15s net.

IN the second volume of the report of the Mackie Ethnological Expedition to Central Africa, Mr. Roscoe again deals with an immigrant nomadic pastoral people, ruling an earlier, or original, agricultural group. The Bahuma belong to the same stock as the neighbouring Baganda and Bakitara, but represent an earlier settlement in the Lake region. They are even more strict than the Bakitara in the observance of milk customs, and owing to their repugnance to intermarriage with their serfs, who lived on vegetable food, they are racially purer than most pastoral peoples of this area. Apart from the description of the ritual of the milk, which necessarily occupies a position in the book commensurate with its prominence in the life of the people, Mr. Roscoe's minute account of the Banyankole is a piece of work the value of which to the ethnologist it is difficult to overestimate. Not only is the culture he describes rapidly passing away, but also it embodies—as for example in its totemic system and belief in the reincarnation of members of the royal family in the forms of various animals—elements which are of great importance in the study of the development of custom and belief.

The Unconscious Mind: a Psycho-Analytical Survey. By Dr. S. Herbert. Pp. vii+230. (London: A. and C. Black, Ltd., 1923.) 6s. net.

THE output of psycho-analytic literature is always on the increase. This volume is an attempt to give a systematic account of the Unconscious on Freudian lines; and it follows the usual plan upon which such works are written, containing considerable illustration of theory from case-histories, examples of myth, wit, art, and the like. There is a good chapter on "Theories of the Unconscious," in which the leading views are stated and criticised with—naturally enough—a strong Freudian bias. On the whole, "The Unconscious Mind" is a simple and straightforward presentation (so far as the subject-matter permits of simplicity and straightforwardness) of the doctrine of the Viennese school; and can be recommended for the literary form of its presentation as well as for being—what it claims to be—"a general outline of our knowledge of the nuconscious, as hitherto ascertained."

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Dutch Pendulum Observations in Submarines.

DR. F. A. VENING MEINESZ, commissioned by the Dutch Geodetic Committee to make pendulum observations on board the Submarine K II of the Royal Dutch Navy during the voyage from Holland to Java (see NATURE of September 15, p. 393), has sent particulars of his observations from Gibraltar, Tunis, and Alexandria.

The beginning of the voyage was extremely disappointing because of the bad weather. For the first five days the sea was continually very rough. The rolling of the ship amounted to 30° to each side, and the pitching to 8 metres; the nights had to be spent strapped to the berths. It was a very rough experience for the first stay on board a seagoing vessel.

After passing Portland Bill in the English Channel, an attempt was made to take observations. Submerged to a depth of 20 metres, the rolling still amounted to $\frac{3}{4}$° to each side, which made observations impracticable. At length, off the Portuguese coast, the weather cleared and it became calmer, but the long swell continued. On September 24 an inquiry was made again into the movements of the submerged ship. The greatest angle of inclination caused by the pitching amounted at the sea-surface to 1°, the rolling to 6° to each side. At a depth of 30 metres, and while the vessel was going in the direction of the swell, the inclination caused by the pitching was at most $\frac{3}{4}$°, which by the use of the horizontal rudder could be reduced to less than $\frac{1}{4}$°; but as the rolling was still $1\frac{1}{2}$° to each side, observations were practically impossible.

Notwithstanding the considerable rolling of the ship, the amplitudes of the pendulums appeared to vary fairly regularly. The principal impediment was the circumstance that the rays from the electric lamp, reflected by the mirrors of the pendulums, went beyond the edge of the film. The actual trouble was therefore of an incidental nature. This induced Dr. Vening Meinesz to devise an arrangement for suspending the whole apparatus from a horizontal axis to be placed lengthwise in the ship in order to neutralise the rolling. He supposed that it would be possible to get this constructed at the workshops of the Royal Navy at Gibraltar.

On September 26, between Cape St. Vincent and Cadiz, the sea was very smooth, and for the first time observations were crowned with success, as at a depth of 25 metres the movements were very small. The first observation was made in a place where the sea was 110 metres deep, the second where it was 480 metres deep. During the second observation the direction of the course was taken successively W.E. and E.W., to test the effect of the speed of the ship on the intensity of gravity, first mentioned by Eötvös.

On the afternoon of September 28, Gibraltar was reached, and immediately Dr. Vening Meinesz took steps for the construction of the suspension apparatus. All the assistance desired was kindly given by the British authorities. The time being very limited, it was necessary to carry on the work day and night without intermission.

During the stay at Gibraltar the observations were worked out, and they proved to be very successful. The discrepancies of the observations showed the accuracy to be greater than was expected from the preliminary observations at the Helder. The effect of the speed of the ship was clearly indicated by the diagrams; the speed could even be derived from these with a difference of but $\frac{1}{2}$ mile from the true value.

On October 3, a few hours before leaving Gibraltar, the suspension apparatus was fitted up on board the submarine. I am glad to express thanks to the British authorities at Gibraltar, who so readily contributed to the realisation of Dr. Vening Meinesz's project.

During the passage between Gibraltar and Tunis, the arrangement proved to be satisfactory in every respect. Although the rolling amounted to 2° to each side, observations were easily practicable. A stay at Tunis, where the submarine arrived on October 7, was again used by Dr. Vening Meinesz for the preliminary computation of his observations. One of these gave the value of g for a sea-depth of 2500 metres with a difference of only 0·003 cm. sec.$^{-2}$ from the theoretical value, which indicates complete isostasy.

Tunis was left on October 13, and Alexandria was reached on October 18; the sea being generally very smooth, observations were made without any difficulty. The Eötvös effect was tested again; the deduced speed of the ship differed only 0·3 mile from the true value.

It appears from the diagrams that the accuracy of the deduced period of oscillation in favourable circumstances may be about 1/1,000,000, and that in a rough sea there is little fear of the divergences exceeding 1/100,000. We must wait, however, for the complete computations before a positive statement will be possible.

It should also be mentioned that the rate of the chronometer was controlled by using the rhythmic time-signals of the Eiffel Tower.

On October 31 the squadron, consisting of the mother ship *Pelikaan* and the three submarines, left Suez; it will touch at the ports of Aden, Colombo, and Sabang, and arrive at Batavia about the middle of December. Dr. Vening Meinesz will carry out observations in the Red Sea and the Indian Ocean, and will ultimately determine, with the invar pendulums, the intensity of gravity at a few stations in Java.

From the results already obtained it may be concluded that, by the method of Dr. Vening Meinesz, investigations of the intensity of gravity by pendulum observations can be realised on the parts of the earth covered by the ocean with almost the same accuracy as on continents and islands. For the study of isostasy, and of Wegener's hypothesis of floating continents, observations in submarines, especially between the coast and the deep sea, will be of the greatest value.

J. J. A. MULLER.

Zeist, November 7.

The True Relation of Einstein's to Newton's Equations of Motion.

THE equations of a space-time geodesic or Einstein's general equations of motion of a free particle are, in usual symbols,

$$\frac{d^2x_\iota}{ds^2} + \begin{Bmatrix} \alpha\beta \\ \iota \end{Bmatrix} \frac{dx^\alpha}{ds} \frac{dx_\beta}{ds} = 0, \quad \iota = 1, 2, 3, 4. \qquad (1)$$

In order to show their relation to Newton's equations of motion, which may be written

$$\frac{d^2\xi_i}{dt^2} = \frac{\partial\Omega}{\partial\xi_i}, \quad i = 1, 2, 3, \qquad (N)$$

Einstein considers the special case of slow motion in a weak gravitation field, *i.e.* such that the metrical tensor components $g_{\iota\kappa}$ differ but little from their Galileian values. Then, neglecting squares, etc., of these small differences and also their derivatives with respect to x_4 (quasi-stationary field), Einstein easily obtains the Newtonian equations as a first approximation, with $\Omega = -\frac{1}{2}c^2 g_{44}$ as the classical potential of the gravitation field. This treatment of the question is repeated, so far as I know, by all exponents of Einstein's theory.

Now, as has recently occurred to me, the true relation of Einstein's equations to those of Newton is of a much more intimate nature, and remains valid, no matter how strong the field and how much space deviates from Euclidean behaviour.

In fact, the frame most natural to adopt for an interpretation of the complicated equations of motion (1) of a particle being clearly its own *rest-system*, let x_1, x_2, x_3 be the space-coordinates of the particle in such a system (the latter, of course, to play its part during an infinitesimal time and to be replaced successively by others and others). Moreover, let for convenience the origin of x_1, etc., be taken at the particle itself. Then, at any instant, $x_i = dx_i/ds = 0 (i = 1, 2, 3)$, and equations (1) will reduce to $ds^2 = g_{44}dx_4^2$ and the three equations

$$\frac{d}{dt}\left(\frac{1}{\sqrt{g_{44}}}\frac{dx_i}{dt}\right) = -\frac{c^2}{\sqrt{g_{44}}}\left\{\begin{matrix}44\\ i\end{matrix}\right\}, \quad . \quad . \quad (2)$$

where $dt = dx_4/c$, the fourth equation being already utilised. Now, with i, k reserved for 1, 2, 3,

$$\left\{\begin{matrix}44\\ i\end{matrix}\right\} = g^{ik}\left(\frac{\partial g_{4k}}{\partial x_4} - \frac{1}{2}\frac{\partial g_{44}}{\partial x_k}\right) + \frac{1}{2}g^{i4}\frac{\partial g_{44}}{\partial x_4}.$$

The coordinates can always be chosen so as to make $g^{41} = g^{42} = g^{43} = 0$. This means a frame not spinning relatively to the stars. In these coordinates then, or in such a rest-platform of the particle,

$$\left\{\begin{matrix}44\\ i\end{matrix}\right\} = -\frac{1}{2}g^{ik}\frac{\partial g_{44}}{\partial x_k},$$

and since the x_i can now always be measured along the principal axes of the operator or matrix g^{ik} (when also $g^{ii} = 1/g_{ii}$), we have

$$\left\{\begin{matrix}44\\ i\end{matrix}\right\} = -\frac{1}{2g_{ii}} \cdot \frac{\partial g_{44}}{\partial x_i},$$

no more to be summed over i, of course. These values substituted in (2) give, with $g_{ii} = -a_{ii}$, and since $x_i = dx_i/dt = 0$,

$$\frac{d^2(\sqrt{a_{ii}}x_i)}{dt^2} = -\frac{c^2}{2}\frac{\partial g_{44}}{\sqrt{a_{ii}}\partial x_i}. \quad . \quad . \quad (3)$$

Now, the space-line element of our platform being

$$dl^2 = a_{11}dx_1^2 + a_{22}dx_2^2 + a_{33}dx_3^2,$$

$\sqrt{a_{11}}dx_1$, etc., are the length elements $d\xi_1$, etc., measured along the axes precisely as in (N), and the right-hand member of (3) expresses the gradient of $\Omega = -\frac{1}{2}c^2 g_{44} +$ const. With a proper choice of the constant, $g_{44} = 1 - 2\Omega/c^2$.

We thus see that, *in the rest-system of the free particle, the general relativistic equations* (1) *become identical with the Newtonian equations of motion, rigorously, i.e.* whether the gravitation field is weak or not ($2\Omega/c^2$ a small fraction of unity or not), and no matter how strongly the platform-space differs from a homaloidal or Euclidean space.

This simple investigation is here given not merely because it seems to put the general equations (1) into an interesting and familiar light, but also because it vindicates the rights of the Newtonian equations of motion.

LUDWIK SILBERSTEIN.
129 Seneca Parkway, Rochester, N.Y.,
September 19.

The Influence of Barometric Pressure on the Specific Gravity of the Surface Water in Indian Seas.

IT has for many years been recognised that any alteration in barometric pressure over a wide expanse of water produces concomitant changes in the surface level, and Prof. J. W. Gregory (*Scottish Geographical Magazine*, 1909, vol. xxv. p. 316), when discussing the level of the sea, pointed out that "the sea in an area beneath high air pressure has its surface pushed downwards and the displaced water rises in the adjacent areas." Since the waves of increased barometric pressure occur at approximately the same time of day in each degree of longitude, it follows that each succeeding elevation and depression of the surface level of the sea travels across the ocean like a wave from east to west. In the region of India the barometric pressure normally exhibits in every twenty-four hours a double rise and fall with maxima at approximately 9.45 A.M. and 10.30 P.M. and minima at 3.30 A.M. and 4.30 P.M.

Investigations of the specific gravity (σ_0) of the

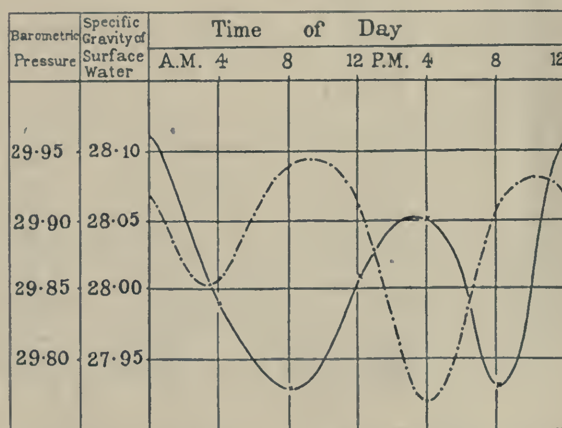

FIG. 1.—Average specific gravity of the surface water and simultaneous barometric pressures during a voyage from Bombay to the Andaman Islands in October 1921.

The continuous line shows the specific gravity, and the dotted line the barometric pressure, in each of the three figures.

surface water of Indian seas have revealed a daily double oscillation that occurs simultaneously with, and must, I think, be due to, the alterations of barometric pressure. This oscillation of specific gravity is, however, only clearly seen in the open sea, because in inshore waters it is obscured by other changes due to tidal flow, etc. During the voyage from Bombay to Port Blair, Andaman Islands, in October 1921, a four-hourly record of the specific gravity of the surface water and the barometric pressure was carefully kept, and the results obtained are shown in Fig. 1. This shows very clearly the way in which, as the barometric pressure falls, the specific gravity of the surface water rises, and vice versa, the two curves alternating with one another.

A variation in the specific gravity of the surface water such as this might be due to (*a*) lateral horizontal movements of masses of water, or (*b*) an upwelling of water from a deeper level. If the latter cause is the true one, then the effect of changes in barometric pressure should be found to depend on the relative specific gravity of the surface water and of water immediately underlying the surface layer. In October, following on the effects of the south-west monsoon, the upper-level water will be diluted and have a lower specific gravity than that immediately below,

and hence an upwelling of deeper water due to a fall in barometric pressure should cause a rise in specific gravity, as seen above.

In Fig. 2, I have given the results obtained in the Bay of Bengal and the Laccadive Sea during the months January and February 1923. It is now found that the oscillation of barometric pressure and specific gravity synchronise with each other. (In this and in Fig. 3, as I have no records made on board

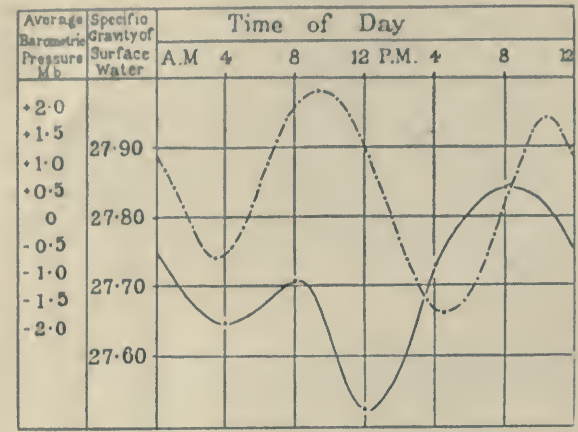

FIG. 2.—Average specific gravity of surface water and average barometric pressure in Indian waters in January and February 1923

ship, I have taken the average barometric pressure registered in Calcutta, as given in the Barometer Manual, 1919.) At this season of the year the rainfall is slight, and, owing to evaporation, the surface layer tends to have a higher specific gravity than water underlying it. In consequence an upwelling of water, owing to lowered barometric pressure, produces a fall in specific gravity.

Finally, in Fig. 3, I have given the results obtained

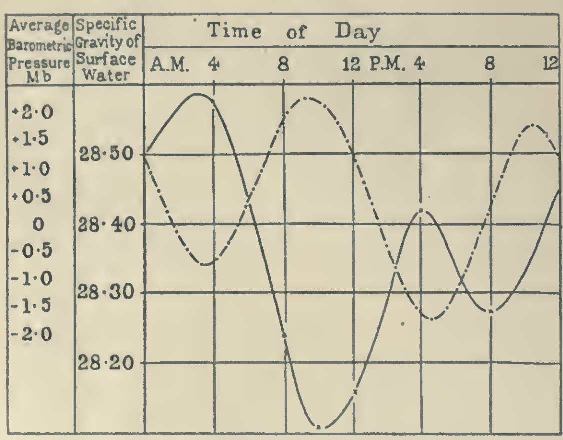

FIG. 3.—Average specific gravity of surface water and average barometric pressure off the west coast of India in May 1923.

off the west coast of India in May 1923. The south-west monsoon had already set in, and there had been a considerable amount of rainfall in the region under investigation since the middle of April. In consequence the surface layer of water had again become diluted, and we now get a return to the condition found in the month of October, *i.e.* a rise of barometric pressure causing a fall in salinity, and a reduction in the pressure being accompanied by a rise due to the upwelling of denser water from below.

Unfortunately, I have no records taken during the month of August, but, judging from the results of the above observations, we should expect to find a fall in barometric pressure accompanied by a rise of specific gravity of surface water, owing to the effect of the monsoon rain in diluting the uppermost levels.

I hope at some future date to be able to publish the full details of my observations, but, as the matter appears to me to be one of considerable interest, I have taken this opportunity of publishing a preliminary note of my results.

R. B. SEYMOUR SEWELL,
Surgeon-Naturalist to the Marine Survey of India.
The Indian Museum, Calcutta.

Spectral Series in the Oxygen Group.

IN the spectrum of oxygen there occur two types of series,—triplet series, and the so-called "singlet" series. The terms associated with the former type are designated by Fowler ("Report on Series in Line Spectra") as *ms*, *mp*, and *md*, while those associated with the latter type are designated as *mS*, *mP*, and *mD*.

One of us (Hopfield) has recently found a number of new oxygen lines occurring in the ultra-violet (NATURE, September 22, p. 437). These appear as fourteen triplets, and for their representation only fifteen different terms are needed. Fourteen of these are previously *known* singlet terms of oxygen ($1S$ to $7S$, $2D$ to $7D$, and $1s$). The fifteenth is a new triplet term, of larger frequency value than any previously known oxygen term. Each of the fourteen triplets represents, on the Bohr theory, the transition from some known singlet energy level to the new triplet level. The nomenclature just given has been used in all previous communications and is identical with that of Fowler, a point apparently not made clear, since the editor of NATURE added a note to the letter of September 22, saying that the S, P, and D terms did not correspond to Fowler's terms of the same designation.

The fourteen oxygen terms include only S (or s) and D terms, and this leads to the conclusion that the new energy level corresponds to a P (or p) term. Whether it is a P or p term is not at once evident. Since the known mp terms of oxygen are triple, while the mP terms are single, the suggestion was made by one of us (Birge) that the new level be designated op_{123}. In fact, the spectral diagrams devised by Brackett and Birge (*Physical Review*, 21, 710, 1923, and Jour. Optical Society of America, now in the press) predict this level at precisely the position found. But it appears, as mentioned in the letter of September 22, that in the op-$1s$ triplet the op_1-$1s$ component is definitely lacking, and a similar phenomenon was later found in the case of the corresponding new sulphur triplets which are discussed in the same communication. Since the $1s$ portion of the op_1-$1s$ designation is known to be correct, and since the known $1s$-mp series of oxygen and of sulphur consist always of triplets, the theory of inner quant numbers leads inevitably to the conclusion that op is *not* the correct designation of the new triple level. Hence the designation has been changed to oP_{123}. An assignment of inner quant numbers to the various terms, according to Sommerfeld's method, then leads immediately to the prohibition of the oP_1-$1s$ component, by the Selective Principle. The inner quant numbers in the case of the triple oP term run in a direction opposite to the usual, in keeping with the "inverted" character

of the new triplets, mentioned in the letter in NATURE of September 22. Again following Sommerfeld (*Ann. d. Physik*, 70, 32, 1923) it is concluded that in the oxygen group the terms labelled by Fowler as mS are single, while the mP terms are triple, and the mD terms quintuple, just as in the case of chromium, which is in the same column of the periodic table. Accordingly the so-called "singlet" series of oxygen are really of a complex nature, a fact that has already been suggested by others (see Fowler, *loc. cit.*, p. 166), while in general the series spectra of the oxygen group are similar to those of chromium, as far as complexity of terms is concerned.

As already noted, similar triplets were found in sulphur, while independently the diagrams by Brackett and Birge had been used to predict the position of most of these new lines, the agreement in all cases being within the limits of error. The diagrams also allow the identification of some ot the other new lines. In particular, the diagrams indicate that the triplets called, in the letter in NATURE of September 22, oP-$3D$ and oP-$4D$ are in reality oP-$2S$ and oP-$3S$ respectively, while those called oP-$2S$ and oP-$3S$ remain unidentified. In addition, the $\lambda 5279$ narrow triplet of sulphur has been identified as $1S$-$2P$. All these points, as well as more general questions, are fully discussed elsewhere by one of us (Birge, "Spectral Series of Divalent Elements," Jour. Optical Society of America, now in the press). One of the conclusions of that paper, derived from a study of the spectral diagrams already mentioned, is that the possible triple levels of the oxygen group, oP and op, while having different sets of inner quant numbers, running in opposite directions, have nevertheless the same average numerical magnitude. But for some unknown reason the oP (valence) level represents a more probable condition, and op does not actually exist. Similarly, in the case of the elements of the second column of the periodic table, the non-appearing os level coincides numerically with the $1S$ valence level.

J. J. HOPFIELD.
R. T. BIRGE.

University of California,
Berkeley,
October 16.

Identification of Pure Organic Compounds.

IN his review of Mulliken's "Identification of Pure Organic Compounds," vol. iv., on p. 581 of NATURE of October 20, your reviewer surely does the author an injustice. Perhaps he is unacquainted with the earlier volumes, as I am, at present, with the latest—that under review. But I can testify to the great value of volumes i. and ii., and have used them regularly for the last two years. In identifying the components of commercial dyestuffs and similar work, Mulliken's methods are far less troublesome and time-expending than the classical method described by your reviewer, and aptly termed by Mulliken in his preface "the Method of the Empirical Formula." I have never experienced failure in preparing a characteristic derivative by following Mulliken's prescriptions, working with quantities of about $\frac{1}{10}$ gram. In fact, his beautifully neat methods for manipulating small quantities deserve to be more widely known, and, in my opinion, it is a matter for regret that your review will prevent this.

W. A. SILVESTER.

Research Department,
British Dyestuffs Corporation, Ltd.,
Blackley, Manchester.

I WELCOME Mr. Silvester's statement, and am glad to hear that Mulliken's methods are appreciated and found useful in technical organic chemistry. In these matters it is only possible to speak from one's own experience, and, as a research organic chemist and teacher of thirty years' standing, I should not dream of allowing my research students to learn to rely on Mulliken's methods. I adopt this attitude, not because his methods are bad or inaccurate, but because they are incomplete, and an extension of his system to meet all requirements would be impracticable.

J. F. T.

Amanita muscaria on Hampstead Heath.

THE letter from Dr. O. Rosenheim in NATURE of October 27, p. 622, would doubtless cause astonishment to many mycologists. *Amanita muscaria* is one of the commonest toadstools, and is to be found amongst almost any clump of birch trees in this country, consequently being a common sight in woods and on commons near London. The association between fungus and tree, moreover, is so constant that it is not unlikely that the mycelium is one of those concerned in forming birch mycorrhiza.

It is, however, the statement that there is difficulty in obtaining this and presumably other common agarics for scientific investigation that occasions this letter. If any chemist or physiologist desire such specimens, I should be pleased to circulate members of the British Mycological Society to that effect. That common species even are sometimes not to be had has been brought forcibly to my notice during the past two seasons. *Lactarius vellereus* was asked for last year at a time when, normally, the season is on the wane. Though the fungus had appeared in quantity in July and August—the season that year was abnormally early—it was exceedingly scarce in October and November. This year, though many mycologists have been on the look-out for it since the beginning of the season, I have heard of no one finding sufficient to fill a vasculum, let alone the promised hampers; *Amanita mappa*, on the contrary, has been so amazingly abundant everywhere that pantechnicons could have been loaded with it.

It should be emphasised also that toadstools have their due season, the majority appearing some time during the period after summer rains until autumn frosts, and consequently it is not possible to provide fresh material of a given agaric all the year round.

J. RAMSBOTTOM.

British Museum (Natural History),
South Kensington, S.W.7,
November 3.

Insecticides.

I AM interested in the question raised in NATURE of October 27, p. 622, as to the efficacy of camphor in preventing moths, and the apparent absence of experimental evidence on the subject. May I suggest that the whole matter of "insecticides" needs investigation. Daily we see upon advertisement hoardings the most alarming pictures, showing the truly devastating effects of popular insecticides on every known and unknown species of the insecta. I have had an opportunity of testing the truth of these statements, and I am profoundly disillusioned.

At the beginning of the rainy season in India my bungalow became in a few days infested with thousands of fleas, which had hatched in the floor matting.

They are smaller than *Pulex irritans* and do not bite so severely. Scores of them marched up my legs as I sat in pyjamas. I bought some tins of that best-known of "insect powders." I covered my legs with it. It had no effect whatever. The fleas bit and jumped with undiminished zest. Before taking steps to rid the bungalow entirely of the creatures, I took a dozen of them, and placed them in an empty biscuit box, and another dozen in a box containing a layer a quarter of an inch thick of the powder. In twenty-four hours the fleas in both boxes were all alive; some were resting actually on the deadly powder. I also shared with many in the trenches the bitter experience that these insect powders had no effect on lice. Ld. de Costobadie.

Mottram, nr. Manchester, November 5.

Lest the good work of American entomologists should be ignored by default, may I direct the attention of your correspondent on the above subject (October 27, p. 622) to two valuable papers recording the results of definite experiments planned against clothes moths? The first, by E. W. Scott, W. S. Abbott, and J. E. Dudley, appeared in 1918 as Bull. 707 of the U.S. Department of Agriculture, "Results of Experiments with Miscellaneous Substances against Bed-bugs, Cockroaches, Clothes Moths, and Carpet Beetles"; the second, "Clothes Moths and their Control," by E. A. Back, appeared in July last as Farmers' Bulletin, No. 1353, of the same Department. These papers contain a mass of information regarding the relative effects and best methods of employing very many different substances against clothes moths belonging to species found in Britain; and curiously enough, in view of the experience of your correspondents, both papers agree in regarding naphthalene in good condition as "one of the safest and best materials for protecting fabrics against moth injury," although it must be used in moderately tight receptacles so that the fabrics remain in a naphthalene-permeated atmosphere. Camphor used in the same way is said to be almost as effective, its fumes killing all stages of clothes moths. James Ritchie.

The Royal Scottish Museum, Edinburgh, November 6.

My own experience of clothes moths in museums extends over many years, and I regret that I cannot agree with "E. E. A." in Nature of October 27, p. 622, that paper is a barrier. The clothes moth "fauna" of Britain is changing. At one time the chief pests were moths belonging to the genus Tinea, which are animal feeders, attacking furs, feathers, wool, silk, etc. To-day the most dangerous pest is *Œcophora* (or *Acompsia*) *pseudospretella*, which, according to Meyrick, was first introduced about 1840. This species eats both animal and vegetable substances. I know it as a disastrous guest of neglected herbaria, preying indifferently on the dried plants or on the paper; and I have observed that it has perforated and penetrated the newspaper coverings of mounted birds and mammals. Fabre, apparently, was unacquainted with this species when he stated that paper is a sure barrier. Pseudospretella certainly prefers slightly damp surroundings, and is known to be a lover of cool climates; it is extremely abundant in London, and is much more conspicuous than any species of Tinea. Perhaps it is not yet established in central or southern France.

Without making any careful experiments, I have believed that naphthalene scattered in cases keeps moths away to some extent. It is not unusual to find a single larva in a store box of mounted insects in circumstances which suggest that the parent has insinuated the egg through a crevice. The larvæ are immune from many well-known insecticides. Fuming with hydrocyanic gas has no effect. The fumes of chloroform cripple the larvæ for a few days; but in a week or so they become active again, and may probably complete their metamorphoses. Drenching with motor spirit is also useless. Larvæ dropped in a strong solution of naphthalene, and then dried until they are thickly encased with a crystal coat, begin to crawl about when the naphthalene is sufficiently evaporated to give freedom of action to the segments. Bisulphide of carbon, in my experience, kills the larvæ.

Bisulphide of carbon, a week or two ago, proved useless in dealing with a small colony of "Museum Beetles"; but drenching the specimen (a mounted bird) with motor spirit appears to have been successful. I take this beetle to be *Ptinus germanus*, described as "scarce" in Cox's "Handbook of Coleoptera," the only work available here at the moment. *Ptinus fur* is the better-known species. Probably the latter insect will require different handling. My own experience of the mites belonging to the genus Glyciphagus is that hydrocyanic gas has no effect, although it is advised by high authority for these disagreeable pests. Like many other "insects," they withstand drenching in petrol, and the only remedy is successive fumings with sulphur dioxide—a plan not always possible in varied collections. A really comprehensive work on museum (and household or warehouse) insects would be very welcome. The losses in stored collections, although for obvious reasons kept secret, are certainly great. This is due not always to neglect, but to the curator's faith in one or other of the well-known insecticides.

I have been told (and certainly credit the tale) that constant vigilance is needed to protect stocks of "Insect Powder" from the ravages of some sort of warehouse pest. Yet this powder, when pure, is very useful indeed in collections, in spite of its comparatively high cost and its messy qualities. Crude experiments on my own part suggest that a mixture of equal parts of borax, sulphur, insect powder, and naphthalene might be scattered or otherwise used as a deterrent. I have tried plunging valuable and delicate specimens such as mounted butterflies and pressed plants, in a solution of celluloid in amyl acetate. When dry, a thin and perfectly invisible "size" of celluloid is left behind. The specimens are thus protected from damp and fungi, and are probably safe from mites also.

An example of the work of Œcophora can here be described. About two years ago a duplicate stuffed wheatear was placed in a glass cupboard, faintly illuminated, and distinctly damp. Three months ago, in clearing out the cupboard, I found that the bird had lost its skin entirely; even the horny rhamnotheca of the beak, and the scales of the feet, had disappeared. Nothing remained except the wires, the bones, and the stuffing; and, strange to say, the stuffing was neither tow nor cotton wool, but waste silk. I have known Œcophora larvæ feeding on a Chinese "joss stick," a compound of resins used as incense, and have found one in an excavation in a "vegetable ivory" nut. In the latter case no other insects were visible, and everything pointed to the moth caterpillar as the culprit.

Fredk. J. Stubbs.

Oldham Corporation Museum.

A Suggested Modification of "Proton" to "Prouton" as a Memorial to William Prout.

THE amazing advances in our knowledge of the composition and structure of matter achieved during the past few decades constitute an important, if not quite final, step toward the establishment of the essential unity of the physical universe.

In reviewing the epoch-making work of J. J. Thomson, whose electrical theory of matter underlies all recent developments in this field, with that of Rutherford, Ramsay, Soddy, Aston, and others in England and elsewhere, one should not be unmindful of the contribution made over a century ago by his compatriot, William Prout, an early apostle of unity.

To all students of chemistry Prout's hypothesis, published in 1816, to the effect that all of the elements are formed from hydrogen by some process of condensation or grouping, has been familiar by reason of the stimulus it has afforded to accurate experimental work. Relegated for many years to the limbo of discarded theories, it has at last emerged to increased plausibility. Although of necessity less specific than the hydrogen-helium theory of Harkins, it is correspondingly simpler, and equally valid if the helium atom, with its four protons and four electrons, be regarded as an intra-atomic polymeride or condensation product of hydrogen. However intricately the more densely populated communities of protons and electrons may be arranged in the heavier atoms, the one proton and one electron of the atom of hydrogen certainly constitute the "first pair" in the chemical Garden of Eden, or present the first stage in the upward evolution of the elements.

In recognition of the genius and insight of William Prout it is suggested herewith that the name "proton" recently assigned to the unit charge of positive electricity, be modified, with some small sacrifice of etymological accuracy, to "prouton," a term with distinctive historical connotation.

ARTHUR WESLEY BROWNE.

Cornell University,
Ithaca, N.Y., U.S.A.

An Uncommon Type of Cloud.

IN NATURE of November 17, p. 725, Dr. Lockyer puts forward a suggestion as to the physics of the formation of "mammato-cumulus" cloud, namely, that it is formed by descent of moist air into colder air below, when there is a reversed vertical temperature gradient, in the same way that "cumulus" clouds are formed by an ascent of warm air (when there is a normal temperature gradient) into colder air above.

Any satisfactory explanation of the formation of this type of cloud would be welcome, but surely "cumulus" clouds are formed by the *adiabatic cooling* when moist air rises to a place where the atmospheric pressure is lower. The general decrease of temperature upwards is only necessary to make such ascent of air possible. A descent of air, such as Dr. Lockyer suggests, must be accompanied by adiabatic warming, since the pressure is increased whatever the general vertical temperature gradient may be. It is true that some cloud might be formed by the mixing which might occur at the surface of separation between two masses of nearly saturated air at different temperatures, but this would not be expected to form the dense globules of cloud actually seen with this type of cloud formation.

G. M. B. DOBSON.

Robinwood, Boar's Hill, Oxford,
November 17.

IN my letter which appeared in NATURE of November 17 I referred to Mr. Arthur Clayden as "the late," when actually he is very much alive. How I came to make this error I cannot understand, but I was most probably thinking of Mr. Clayden as the *late* Principal of the University College, Exeter, and so made the mistake. I much regret the error, and shall be glad if this correction of it can appear in an early issue of NATURE.

WILLIAM J. S. LOCKYER.

Norman Lockyer Observatory,
Sidmouth, S. Devon,
November 20.

National Certificates in Chemistry.

I HAVE observed on page 610 of NATURE for October 27 a reference to the scheme of examinations for national certificates in chemistry.

The writer of the article, upon the basis of an expression of opinion commencing with the word "apparently," proceeds to criticise something on which he is not fully informed. The scheme *is* "designed to secure all the advantages of internal examinations and of reasonable freedom in the arrangement of the courses of work to meet local conditions and needs," and the writer need not fear that there is any truth in the suggestion that before courses of study are recognised they are modified or mutilated by the Board of Education.

So far as national certificates in chemistry and the courses leading thereto are concerned, the Board acts only in conjunction with the Institute of Chemistry.

The experience of the first two examinations for such certificates has amply demonstrated the usefulness of the scheme. No complaint of bureaucratic intervention has been submitted either to the Board or to the Institute.

So far from insisting on "that machine-like uniformity beloved by bureaucrats," the examination papers have, in fact, been set either by the local schools or by their own affiliated groups—such as the Union of Lancashire and Cheshire Institutes.

The view of the writer as to the need of "some measure of central control and to some sound and official organisation" is incontestable: those desiderata are precisely those which the scheme is designed to attain.

RICHARD B. PILCHER,
Registrar and Secretary.

Institute of Chemistry,
30 Russell Square, London, W.C.1,
November 13.

MR. PILCHER will know that before an educational institution can submit candidates for national certificates the course of study proposed must be approved by the Board. This, of course, is absolutely necessary and desirable, but it is at this stage that modifications may be suggested by the Board—the alternative to acceptance being refusal to place the institution concerned on the approved list. I do not suppose for one moment that modifications of courses proposed are not necessary sometimes, but I do suggest that the trend of the modifications is towards uniformity of syllabuses.

I have no suggestions to make, at present, on the actual conduct of the examinations, and I know that the papers are set by the local schools and assessed by gentlemen whose work is not questioned. My reference was made distinctly to the pre-recognition stage, and I can assure Mr. Pilcher that I did not write without some knowledge.

I would also point out that I was referring to complete courses of work—including subjects ancillary to the main subject, and covering a period of from three to five years.

THE WRITER OF THE ARTICLE.

Zoological Bibliography.

REFERRING to my letter on this subject in NATURE of November 3, p. 652, I am asked to state that the recommendation that the size of the publications of scientific societies should, if possible, be demy octavo, originated with a committee of the British Association on the size of periodicals, not with that on Zoological Bibliography and Publication; and that this was also the recommendation of the Corresponding Societies' Committee at Liverpool.

T. SHEPPARD.

The Museums, Hull.

THE British Association Committee on Zoological Bibliography and Publication desires me to emend a statement in the friendly and welcome letter which Mr. T. Sheppard has addressed to you on behalf of the Corresponding Societies' Committee (NATURE, November 3, p. 652). The recommendation that the format of a society's publication should be demy octavo (approximately, $9 \times 5\frac{3}{4}$ in., or $22{\cdot}5 \times 14{\cdot}5$ cm.) does not occur in the last report of my Committee or in any of its previous reports.

If that recommendation was made either by the Corresponding Societies' Committee or by the Conference of Delegates from those societies, it will doubtless have been transmitted to the Council of the British Association, and will presumably be communicated by that body to the Committee which it has appointed to report on such questions.

Meanwhile I am to add that my Committee already has a different proposal of the same nature laid before it, and that it will report on the subject in due course.

The only recommendation by the Conference of Delegates of which I have received information is as follows: "To urge the adoption by scientific societies of the bibliographical recommendations contained in the current Report of the Zoological Publications Committee."

May I request those who may desire a copy of the Committee's last report to address themselves to me at the Natural History Museum, London, S.W.7, and not to the Secretary of the British Association.

F. A. BATHER,
Secretary.

November 12.

A Standard System for Scientific and Technical Publications.

THE enormous amount of current scientific and technical literature is a matter of common remark. It goes to swell an ever-increasing accumulation, of which a large portion, comprising research data, observations, measurements of values, and so forth, remains of permanent value. The various published indexes serve to keep account of it, but the labour required to make a comprehensive review over any range of recorded fact is considerable, and will steadily increase as time goes on. With the view of alleviating such labour I have worked out in detail an organised publication system, as specified below in two parts.

1. *The Standard Page Size Scheme.*—A certain suitable size should be nominated as the standard page size, and be adopted generally for scientific and technical publications, except for special reason to the contrary. The size would be chosen by experts, and would be some compromise between a small magazine size and a book size.

2. *The General Encyclopædia Scheme.*—Standard size publications of booklet and pamphlet form to be perforated at a standard spacing for filing on the ring-book, or other similar system. Each of such publications to have a word or phrase, descriptive of the contents, printed on the top right-hand corner of the front page, so that by this "cyclopædic phrase" such publications can be filed in alphabetical order. In the case of periodicals, each important article should begin at a right-hand page, and occupy a whole sheet or set of sheets, the space left over being left blank, or filled with advertisements or small matter. The periodicals should be so bound that such articles can be withdrawn without mutilation; the standard perforation and cyclopædic phrases should be provided as for pamphlets.

Upon the adoption of the system, pamphlets and articles withdrawn from periodicals would be filed in an orderly and compact collection in covers of book size, in alphabetical order, or order of classification as desired. But I specially argue that the system would permit of a variety of arrangements of great service to those who desire to make any review over recorded fact. Only certain classes of periodicals need conform to the system, in order to derive the main advantages of it, and existing indexing arrangements need not be upset by it.

The above will give only the roughest idea of the system; it has many modifications, and there are very many considerations to be taken into account. But I am prepared to go into precise details with any committee set up to consider the system from a general scientific point of view. Such a committee might, for example, be appointed by the British Association. I shall also be glad to supply an account of the system to any person specially interested.

J. F. POWNALL.

20 Watery Lane, Merton Park,
London, S.W.20.

A Fossil Caddis-case.

ATTENTION has frequently been directed of late to the extraordinary persistence in time of various insect structures, as shown by fossils. It might be assumed that the reactions and instincts of insects were similarly ancient, and of this we have a certain amount of actual proof, as in the case of some of the ants, the remains of which are so abundantly preserved in Baltic amber. When I was recently in Vladivostok, Dr. A. Kryshtofovich showed me some curious insect cases found fossil in the Tertiary rocks at Posiet, a locality in Siberia close to the border of Korea. One of these cases, which he gave me, proves on examination to be that of a caddis-fly of the genus Phryganea, quite similar to the modern *Phryganea grandis*. It is composed of pieces of *Sequoia langsdorfii*, which are arranged side by side in the usual spiral fashion, and are about 5 mm. long and 1·2 mm. wide, the case itself being 7 mm. wide. The species represented by these cases may be called *Phryganea Kryshtofovichi* n. sp. (Fig. 1). The cases from the Miocene of Oeningen in Baden, long ago named *Phryganea antiqua* by Heer, do not belong to this genus. The true Phryganea case is quite a specialised structure, with a definite spiral arrangement, which we now see to have been evolved long ago, the Posiet beds being Lower Miocene or probably earlier. In the insect-bearing beds on the Kudia River, Siberia, N. lat. 46°, I secured a wing of Phryganea, which will be described elsewhere.

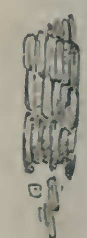

FIG. 1. — *Phryganea Kryshtofovichi* case.

T. D. A. COCKERELL.

University of Colorado, Boulder,
Colorado, Oct. 10.

Hormones.[1]

By Prof. E. H. Starling, C.M.G., F.R.S.

In the dedication to his work, Harvey compares the heart to the sovereign king, and throughout he continually recurs to what we should now describe as the "integrative function" of this organ. In virtue of the circulation which it maintains, all parts of the body are bathed in a common medium from which each cell can pick up whatever it requires for its needs, while giving off in return the products of its activity. In this way each cell works for all others—the lungs supply every part with oxygen and turn out the carbon dioxide which it produces, the alimentary canal digests and absorbs for all, while the kidneys are the common means of excretion of the soluble waste products of the body. Changes in any one organ may therefore affect the nutrition and function of all other organs, which are thus all members one of another. But, in addition to enabling this community of goods, the circulation affords opportunity for a more private intercourse between two or at any rate a limited number of distant organs.

It is now eighteen years since I directed attention to the chemical messengers or hormones which are employed by the body for this purpose. As an illustration of the method by which they work, I adduced the example of carbonic acid gas, which is the product of all cellular activity and at the same time has a specific excitatory effect on the respiratory centre, so that the respiratory movements keep pace with the needs of the whole body for oxygen. The typical hormone, however, is a drug-like body of definite chemical composition, which in a few cases is actually known, so that the substance has been synthesised outside the body. It is more or less diffusible, and may even withstand without alteration the temperature of boiling water. It is generally easily oxidisable in a neutral or alkaline medium, so that after its production it does not remain long in the blood; it delivers its message and is then destroyed. Each specific hormone is manufactured by a group of cells and turned into the blood, in which it travels to all parts of the body, but excites definite reactions in one or a limited number of distant organs. The production and action of these substances are continually going on in the normal animal. They are necessary to health, and their production in excess or in deficit gives rise to disease and maybe to death.

Typical of all hormones is secretin, a substance produced in the epithelial cells lining the upper part of the small intestine when these come in contact with weak acid, so that it is set free in normal circumstances by the passage of the acid chyme from the stomach into the duodenum. Directly it is produced it is absorbed into the blood and travels round to the pancreas, to the liver, and to the intestinal glands, in all of which it excites secretion. By means of this chemical reflex the arrival of the products of gastric digestion in the small intestine evokes within a couple of minutes the secretion of the three juices the co-operation of which is necessary for completing the work of digestion and solution of the food, already begun in the stomach. It is probable that this mechanism is but one of a whole chain of chemical reflexes responsible for the orderly progression of the various stages in the digestion of food.

These hormones may apparently be formed by any kind of tissue. In many cases a gland which has, in the evolutionary history of the race, poured its secretion by a duct into the alimentary canal or on to the exterior, loses its duct and becomes a ductless gland, the secretion being now transferred either immediately or through the lymphatics into the blood stream. In either case these chemical messengers may be formed from masses of cells which have at no time had a glandular structure and may be modified nervous tissue, germinal tissue, or some part of the mesoblast.

As a type of the ductless gland derived from one with an external secretion the most familiar example is the thyroid. The physiological action of its internal secretion and the morbid results of its excess or deficiency, affecting tissue growth and development, metabolism, and mentality, are familiar to all. In recent years the active substance has been actually isolated, and its constitution determined, by Kendal, who has shown that it is an iodine derivative of an amino-acid, tryptophane. It seems almost a fairy tale that such widespread results, affecting every aspect of a man's life, should be conditioned by the presence or absence in the body of infinitesimal quantities of a substance which by its formula does not seem to stand out from the thousands of other substances with which organic chemistry has made us familiar.

Although we do not yet know their constitution, the chemical messengers associated with the reproductive organs are possibly even more marvellous in the influence they exert on the different parts and functions of the body. The effects of castration have been the subject of observation almost from the beginnings of civilisation, but it is only during the last few years that definite proof has been brought forward showing that these effects are due to the removal of chemical messengers normally produced in the testes. The whole differentiation of sex, and the formation of secondary sexual characters, are determined by the circulation in the blood of chemical substances produced either in the germ cells themselves or, as seems more probable, in the interstitial cells of the testis and ovary, which themselves are probably derived from the germ cells of the embryo. Thus it is possible by operating at an early age to transfer male into female and *vice versa*. Removal of the ovaries from a hen causes the assumption of male plumage; the removal from a young cock of the testes and their replacement by the implantation of ovaries cause a disappearance of the comb and the assumption of the plumage of the hen. Each animal as concerns its general build and colour has a neutral form which, as has been shown by Pézard, results from the extirpation of either testes or ovaries. In fowls the neutral form, as judged by the plumage, approximates the male, whereas in sheep the neutral form resembles the female. There is no question that, by the

[1] From the Harveian Oration, entitled "The Wisdom of the Body," delivered before the Royal College of Physicians of London on St. Luke's Day, October 18.

implantation of ovaries or testes into the fœtus at a sufficiently early age, one could produce the whole development of the internal and external genitalia corresponding to the sex of the gland implanted.

It is worthy of note that these sex characters affect also the mentality and the reactions of the animal, although they are quite independent of any nervous connexions. Here, as in the case of the thyroid, the functions of the central nervous system in their highest manifestations depend on the circulation in the blood of chemical substances or hormones. The wonderful development that takes place in the female after conception to fit her to nourish the fœtus as well as the young child, is also due to hormones, produced in some cases perhaps in the ovaries, in other cases in the product of conception itself.

We owe to Schafer the knowledge of the internal secretion of the medulla of the suprarenal bodies. As Cannon has pointed out, this secretion is poured into the blood during conditions of stress, anger, or fear, and acts as a potent reinforcement to the energies of the body. It increases the tone of the blood vessels, as well as the power of the heart's contraction, while it mobilises the sugar bound up in the liver, so that the muscles may be supplied with the most readily available source of energy in the struggle to which these emotional states are the essential precursors or concomitants.

Wonderful, too, is the influence exerted by the secretions of the pituitary body. This tiny organ, which was formerly imagined to furnish the mucus to the nasal cavities, consists of two lobes which have different internal secretions. That produced by the anterior lobe seems to influence growth, excess producing gigantism or acromegaly, while deficiency leads to retarded growth and infantilism. The posterior lobe, which in aspect would seem but a small collection of neuroglia, nevertheless forms one or more substances which, circulating in the blood, have the most diverse influences on various parts of the body. They cause contraction of the uterus and of the blood-vessels (these are possibly two distinct substances); they may increase or diminish the flow of urine; they affect the excretion of chlorides by the kidney; and, according to Krogh, their constant presence in the blood is essential for maintaining the normal tone of the capillaries. In the frog the post-pituitary hormone is responsible for the protective adaptation of the colour of the skin to the environment, an adaptation which is effected by retraction or expansion of the pigment cells or chromatophores of the skin; and, if we may accept Kammerer's conclusions, the pituitary hormone which is poured into the blood for this purpose affects the germ cells themselves, so that individuals born of parents that have lived in light or dark surroundings are correspondingly light or dark—a real transmission of acquired peculiarities, effected not by the gemmules of Darwin, but by the influence of a soluble diffusible hormone on the germ plasm.

In the multiplicity and diversity of the physiological effects produced by these various chemical messengers, one is apt to lose sight of the fact that we are here investigating one of the fundamental means for the integration of the functions of the body. These are not merely interesting facts which form a pretty story, but they are pregnant of possibilities for our control of the processes of the body and therewith for our mastery of disease. Already medical science can boast of notable achievements in this direction. The conversion of a stunted, pot-bellied, slavering cretin into a pretty, attractive child by the administration of thyroid, and the restoration of normal health and personality to a sufferer from Graves's disease by the removal of the excess of thyroid gland, must always impress us as almost miraculous. In the same way we may cure or control for the time being diabetes insipidus by the injection of the watery extract of the posterior lobe of the pituitary body. The latest achievement in this direction is the preparation by Banting and Best in Canada of the active principle normally formed in the islets of the pancreas, and the proof that the diabetic condition in its severest forms can be relieved by its subcutaneous administration.

In my Croonian Lectures I asserted that, if a mutual control of the different functions of the body be largely determined by the production of definite chemical substances in the body, the discovery of the nature of these substances will enable us to interpose at any desired phase in these functions, and so to acquire an absolute control over the workings of the human body. I think I may claim that, in the eighteen years that have since elapsed, we have made considerable progress towards the realisation of this power of control which is the goal of medical science. But there still remain much to be done and many difficulties to be unravelled, and it may be worth our while to consider along what lines researches to this end must be directed.

There are no doubt many hormonic relationships of which at present we are unaware, since every year research adds to their number. But assuming we know that such and such an organ produces an internal secretion which is necessary for the normal carrying on of a given function or functions, we may desire to diminish or enhance its effects in a patient or to replace it when it seems to be entirely lacking. There seem to be three possible methods by which we medical men can interpose our art in the hormonic workings of the body.

(1) In the first place, we may find what is the effective stimulus to the production of the hormone, and, by supplying this, increase its production by the responsible cells. For example, we know that by the administration of acid, or at any rate by increasing the passage of weak acid from the stomach to the duodenum, we can enhance the production of secretin and so of pancreatic juice and the other juices. Probably, therefore, when we give dilute acids to assist gastric digestion we are setting into motion the whole chain of reflex processes in the alimentary canal, and the chief value of our administration may be its effect on the pancreas. But in a large number of cases we do not yet know what is the effective stimulus to the production of these internal secretions. In the case of the adrenals we know the secretion can be augmented through the central nervous system and the splanchnic nerve under the influence of emotions or of lack of oxygen, but we have no knowledge of the factors determining the production of the pituitary hormones or of insulin by the islets of Langerhans, and this

condition of ignorance extends to most of the other ductless glands.

In some cases deficient production of a hormone may be due to the absence from the food and drink of some necessary constituent. Thus iodine is essential to the formation of the specific secretion of the thyroid gland (iodothyrin). If iodine be entirely absent from the drinking water and the soil, so that it is not contained even in minute quantities in the vegetable food grown in the district, the thyroid undergoes hyperplasia—in vain an endeavour to make bricks without straw, to produce its proper hormone without iodine. This seems to be the cause of the great prevalence of simple goitre in certain districts—especially in Switzerland and in parts of the United States. It has been shown that goitre can be practically eliminated from these districts by the occasional administration of small doses of iodine or iodides (Marine, Lenhart, Kimbull, and Rogoff). These results were communicated in 1917 to Dr. Klinger of Zürich, and as a result of his experience the Swiss Goitre Commission has recommended the adoption of this method of goitre prevention as a public health measure throughout the entire State. Already great progress has been made in the abolition of this disease from the country. Thus the incidence of goitre among all the school children of the canton of St. Gallen has been reduced from 87·6 per cent. in January 1919, to 13·1 per cent. in January 1922.

(2) Where a disordered condition is due to diminished production of some specific hormone we may extract the hormone from the corresponding gland or tissue in animals. It is characteristic of these hormones that, so far as we know, they are identical throughout all the classes of vertebrates, and it is possible that they may be found far back in the invertebrate world. This method is easy when, as in the case of the thyroid, the active principle is stored up in the gland and is unaltered by the processes of digestion, so that we can obtain all the curative effects of the hormone if we administer dried thyroid by the mouth. We have no evidence that any other of the hormones with which we are acquainted partake of this resistance to digestion, so that to produce their specific effects they have to be introduced by subcutaneous injection —a great drawback when the administration has to provide for the constant presence of a small concentration of the hormone in the blood and tissues. In the case of insulin, for example, it seems necessary to repeat the injection every twelve hours to obtain any continuity of action, and the same thing probably applies to the pituitary extract, while in the case of the genital hormones no trustworthy effect has been obtained except by the actual implantation of the organ from an animal of the same family.[2]

[2] In my Croonian Lectures in 1905 I reported some experiments made in conjunction with Dr. Lane-Claypon, in which I had produced hypertrophy of the mammary glands in virgin rabbits, and in some cases actual secretion of milk, by the daily subcutaneous injection of the filtered watery extract of young rabbit fœtuses. Similar results were obtained by Foà. But a weak point in these experiments was that the ovaries had not been previously extirpated. Ancel and Bouin have shown that in the rabbit the mere rupture and discharge of a Graafian follicle, with the subsequent growth of a corpus luteum, are sufficient to cause hypertrophy of the mammary glands (the effective hormone presumably having its seat of manufacture in the luteal cells). It seems possible, therefore, that the effect of our injections may have been on the ovaries, and that the growth of the mammary glands was only a secondary and indirect result. I do not therefore now regard our experiments as conclusive.

We may, however, look forward to the day when the chemical constitution of all these hormones will be known, and when it may be possible to synthesise them in any desired quantity. We may then be able to overcome the inconvenience of subcutaneous injection by giving relatively colossal doses by the mouth, or we may be able to modify their constitution to a slight extent so as to render them immune to the action of digesting fluids, without affecting their specific action on the functions of the body.

(3) The ideal, but not, I venture to assert, the unattainable, method will be to control, by promotion or suppression, the growth of those cells, the function of which is to form these specific hormones. Though this method seems at present far from realisation, the first steps in this direction have already been taken. It must be remembered that the power of controlling growth of cells involves the solution of the problem of cancer. Here the experiments on the growth of normal cells outside the body have shown that they can be stimulated to vie with cancer cells in the rate of their growth, or can be inhibited altogether according to the nature of the chemical substances with which they are supplied. We know that the growth of certain cells, such as those of the mammary gland or of the uterus, is excited by specific chemical substances produced in the ovary or fœtus; and we may be able to find specific substances or conditions for any tissue of the body which may excite growth which is retarded, or diminish growth when this is in excess.

It may be that in some cases purely mechanical interference will suffice. Thus in experiments by Steinach and others it has been found that ligature of the vas deferens close to the testis, while causing atrophy of the seminiferous cells, brings about overgrowth of the interstitial cells, which, as we have seen, are chiefly responsible for the hormones determining the secondary sexual characters. Among these secondary sexual characters must be classed the whole of a man's energies. Virility does not mean simply the power of propagation, but connotes the whole part played by a man in his work within the community. As a result of this hypertrophy these authors claim to have produced an actual rejuvenation in man, and thus to have warded off for a time senility with its mental and corporeal manifestations. Further experiments and a longer period of observation are necessary before we can accept these results without reserve, but it must be owned that they are perfectly reasonable and follow, as a logical sequence, many years' observations and experiments in this field.

It would indeed be an advantage if we could postpone the slowly increasing incapacity which affects us all after a certain age has been passed. Pleasant as it would be to ourselves, it would be still more valuable to an old community such as ours, where the arrival of men in places of rule and responsibility coincides frequently with the epoch at which their powers are beginning to decline. The ideal condition would be one in which the senile changes affected all parts of the body simultaneously, so that the individual died apparently in the height of his powers. For it must not be thought that in any such way we could prolong life indefinitely. Pearl has pointed out that

if all the ordinary causes of premature death were eliminated, this would increase the average duration of life by not more than thirteen years. On the other hand, he shows that the children of long-lived parents have an expectation of life which is twenty years greater than that of the average individual.

It is evident, then, that if longevity is our goal it is not medical science we must look to but eugenics, and I doubt whether the question is one with which we are concerned. The sorrow of the world is not the eternal sleep that comes to every one at the end of his allotted span of years, when man rests from his labours. It is the pain, mental and physical, associated with sickness and disability, or the cutting off of a man by disease in the prime of life, when he should have had many years of work before him. To us falls the task of alleviating and preventing this sorrow. In our childhood most of us learnt that suffering and death came into the world through sin. Now, when as physicians we stand on the other side of good and evil, we know that the sin for which man is continuously paying the penalty is not necessarily failure to comply with some one or other of the rough tribal adjustments to the environment, which we call morality, but is always and in every case ignorance or disregard of the immutable working of the forces of Nature, which is being continually revealed to us by scientific investigation.

In spite of the marvellous increase in knowledge, to some aspects of which I have directed your attention, suffering is still widespread amongst us. Only by following out the injunction of our great predecessor —to search out and study the secrets of Nature by way of experiment—can we hope to attain to a comprehension of "the wisdom of the body and of the understanding of the heart," and thereby to the mastery of disease and pain which will enable us to relieve the burden of mankind.

The Equation of Van der Waals.[1]

By J. H. JEANS, Sec. R.S.

VAN DER WAALS' equation

$$\left(p+\frac{a}{v^2}\right)(v-b)=aT$$

expresses the result of supposing a molecule to be endowed with two distinct physical properties—finite size, giving rise to the term b, and cohesive force, giving rise to the term a/v^2. The physical meaning of the equation is best exhibited by drawing diagrams of isothermals of the familiar type. Representing different gases there will be different diagrams corresponding to different values of a and b. It is, however, readily shown that one diagram of this type can be made to represent all values of a and b, and so the isothermals of all gases, by suitable expansions and contractions of its horizontal and vertical scales. On removing the scale from any single diagram we have a universal diagram which represents the p, v, T relation for all gases, but without specifying the scale. The circumstance that such a diagram is possible is equivalent to the so-called "Law of Corresponding States"; this is now seen to be a mathematical consequence of Van der Waals having confined himself to a two-constant specification of molecular structure.

Thus the accuracy, or the reverse, of the law of corresponding states provides a test of the sufficiency of Van der Waals' two-constant specification of a molecule. In actual fact the law is not very closely obeyed; the deviations show distinct correlation with atomicity, and so suggest that the two-constant specification is not altogether adequate—a full treatment must take account of differences of atomicity (or physical shape) as well as of differences of size and cohesive power.

Van der Waals explained his cohesive power by the supposition that all matter possesses inherent powers of attraction for all other matter. Gravitational attraction is numerically far too small to come into the question at all, so that it is to the electrical structure of matter that we must look for the origin of this supposed universal attraction.

If molecules were electrically charged structures, similar molecules would repel one another; as they are electrically neutral, they will repel in some orientations and attract in others, but two molecules meeting at random are as likely to repel as to attract. It is only when the *duration* of molecular encounters is studied that we find an explanation of the preponderance of attraction over repulsion—attractive encounters draw the molecules farther and farther into each other's sphere of influence, and so last longer than repulsive encounters. Comparing the two types of encounters, the "birth rate" is the same for each, but the "expectation of life" is longer for attractive encounters, so that for the encounters in being at a specified instant, there is a preponderance of attractive encounters, and hence a resultant attractive force. This attractive force, however, originates far more in an abstruse theorem of statistical mechanics and far less in an inherent property of matter, than Van der Waals supposed.

If this interpretation is right, the cohesive forces must disappear at very high temperatures and must steadily increase with decreasing temperatures, so that a must be a function of the temperature and not, as Van der Waals supposed, a constant. In point of fact, all attempts to bring Van der Waals' equation into closer agreement with observation begin by making a a function of the temperature. Moreover, a is found to vanish at infinite temperatures in conformity with the suggested explanation.

The second constant b was supposed by Van der Waals to have its origin in the finite sizes of the molecules. If, for example, the hydrogen molecule is regarded as a sphere, its radius as calculated from the observed value of b is found to be $0{\cdot}64\times10^{-8}$ cm. The same radius can be calculated independently in other ways; the coefficients of viscosity, of conduction of heat and of self-diffusion all agree in yielding the value $0{\cdot}68\times10^{-8}$ cm. The average of these, $0{\cdot}66\times10^{-8}$ cm.,

[1] Synopsis of part of the Van der Waals Memorial Lecture delivered before the Chemical Society on November 8.

would give for the hydrogen *atom* a volume equal to that of a sphere of radius $0{\cdot}53 \times 10^{-8}$ cm. But the normal hydrogen atom, as is now known from the researches of Bohr, consists of two electric charges, describing a circular orbit, one about the other, of radius precisely equal to $0{\cdot}53 \times 10^{-8}$ cm. As regards collisions with other molecules, this invertebrate structure, consisting of two point-charges with no material connexion between them, appears to reserve for itself a three-dimensional spherical volume with as much precision as though it were a sphere of infinite hardness.

The explanation of this infinite hardness is to be found in the intangible fetters of the quantum dynamics. The nature of these fetters is not in the least understood, but it is believed that they are such that no force in creation can cause the electron of the hydrogen atom to describe a smaller orbit than the normal orbit of radius $0{\cdot}53 \times 10^{-8}$ cm. If it is further supposed that this orbit is free to assume all orientations in space we begin to understand why it is legitimate, for kinetic theory purposes, to treat the hydrogen atom as an infinitely hard sphere of radius $0{\cdot}53 \times 10^{-8}$ cm. The quantum theory brings us back, in a sense, to the infinitely hard spherical atoms of Lucretius, and the radius of these spherical atoms can now be calculated with precision from the quantum theory; their infinite hardness is beautifully exemplified in the experiments of Franck and Hertz.

It is thus seen that the *a* and *b* of Van der Waals admit of exact interpretation in terms of the physical conceptions of to-day. His *b* arises from what we may call the quantum forces—the perfectly unyielding restraints which bind the electrons of an atom down to definite orbits—while his *a* arises from the ordinary electric field of force. It is the *b* of Van der Waals which saves us from immediate annihilation, through positive and negative charges rushing together to their mutual destruction, just as it is his *a* which saves us from rapid disintegration.

The Nerves of Plants.[1]

By Prof. Henry H. Dixon, F.R.S.

The general similarity of the distribution of the fibro-vascular bundles in plants and that of the nerves in animals was early noticed. These structures in plants were in consequence often called nerves. However, anatomists and physiologists alike have long held the view that the likeness is merely superficial, and is not based on any real physiological or anatomical resemblance.

In plants—as in animals—the receptive and responsive regions are often quite distinct from one another, and may be widely separated. What becomes of the stimulus between the two, and how is it transmitted? Remarkable experiments during the last ten years have given the answers to these questions.

First may be summarised, in a few words, Ricca's work on the sensitive plant, Mimosa. The phenomena of transmission of stimuli in this plant are as striking as they are well known. The stimulus is propagated through its organs at velocities variously estimated at 10-20 mm. per sec. This speed is fast among plants, but very slow when compared with the velocity of transmission of stimuli along animal nerves.

Two views were suggested to account for this propagation. The first referred the passage of the stimuli to those excessively fine strands of protoplasm which, penetrating the walls of the living cells, place the protoplasts of adjacent cells in communication with one another. This view was a product of a period obsessed with the physiological importance of these then recently discovered protoplasmic fibrillæ, which, in all probability, have only a developmental significance. These fibrillæ composed of living matter were supposed to convey stimuli just as the living processes of the nerve cells do in the animal body.

This view was soon rendered untenable when it was shown that stimuli are effectively transmitted even after the protoplasm of the cells of the transmitting organs was killed by the application of heat.

To meet this new growth of knowledge Haberlandt developed his theory, that the stimuli are transmitted in Mimosa in the form of a pulse in the water filling certain elongated tubular cells situated in the bast of the bundles. At the best this was an unsatisfactory theory. For this method would require a much higher velocity of transmission than is observed, and it was wellnigh impossible to imagine how the turgor requisite to transmit this pulse could be maintained after the protoplasts of these tubes had been rendered permeable by heat.

In 1914 Ricca gave the *coup de grâce* to the pulse theory. He showed that the stimulus is transmitted through a strand of Mimosa wood from which all the bast, including the tubes of supposed transmitting function, had been removed for a considerable length. By a series of beautiful experiments Ricca showed that the wood, as Dutrochet long ago believed, transmits the stimulus, and that it does this even when all its living elements are eliminated. Further, he demonstrated that the mechanism of the transport is the transpiration current. This carries in its stream a substance, or hormone, originating from the receptive cells, to the cells of the reactive region and so evokes their response. Ricca's work also disposes of a more recent view that the stimulus is transmitted as an electrical disturbance in the bast.

Almost at the same time as Ricca was disposing of the older views regarding the transmission of stimuli in Mimosa, Boysen-Jensen was carrying out experiments on the phototropic reactions of seedlings, which were bound to have a profound effect on the received views regarding the propagation of stimuli.

When the tip of a grass-seedling is illuminated on one side a stimulus is transmitted from the receptive region downwards in the seedling and evokes a curvature in the shaded part. Boysen-Jensen found that this stimulus was transmitted downwards even when the protoplasmic continuity of the cells of the receptive apex with those of the responsive region was severed by complete section.

[1] Synopsis of a lecture delivered before the Royal Dublin Society on November 9.

Paál repeated and confirmed Boysen-Jensen's results and added the important observation that the stimulus can pass a slice of pith 0·1 mm. thick impregnated with gelatin intercalated between the receptive and responsive regions. Similar work has been since carried out by Stark on thigmotropic and traumatotropic stimuli. This experimenter brought to light the fact that the receptive tip of one plant may be transferred to the base of another and after stimulation may determine curvature in the latter. Furthermore, the certainty of this response to thigmotropic stimuli depends, other things being equal, upon the phylogenetic affinity of the two parts. Recently Snow has shown that the gravitational stimulus is transmitted across protoplasmic discontinuities in the seedlings of *Vicia faba*.

From the foregoing it is quite evident that protoplasmic continuity is not requisite for the transmission of stimuli in the higher plants. The localisation of the positive and negative responses respectively to one side of the reacting region and the velocity of transmission will not allow us to assign the propagation to simple diffusion; but these characteristics point clearly to the transpiration-stream. It affords the localised delivery and the necessary velocity. Introduction of the requisite hormones may be effected through uninjured cells, or along moist wound surfaces. This consideration explains how it is that continuity between the vascular bundles of the receptive tip and those of the responsive base is not necessary to secure the reaction. Thus, there is great probability that in these plants, as in Mimosa, the transmission of stimuli is effected by the transport in the transpiration-stream of a substance derived from the receptive cells, and conveyed by this means in the wood of the vascular bundles to the responsive region. We may imagine that this substance is first liberated into the transpiration stream by changes in the permeability of the receptive cells, and response is evoked in the reactive cells by similar alterations in permeability.

Whatever the intimate mechanism of the system is, the subject of the transmission of stimuli through plant tissues offers a striking example of the swing of the pendulum of scientific opinion. The view based upon superficial resemblances, that the vascular bundles are the nerves of plants, was long abandoned, but now we see there is clear evidence that they actually transmit stimuli from the sensory to the motor regions, and so perform the function of nerves. The foregoing summary of recent work indicates how differently in detail this connexion is established in plants and animals.

Obituary.

MRS. HERTHA AYRTON.

APPEAL is made to me to give some account of Hertha Ayrton, the wife of my former colleague, who died last August.

"Is the study of heredity a science or a pure romance?" asks Mrs. Trevelyan, in her biography of her mother, Mrs. Humphry Ward. I would set the question in another form: Is *das ewig Weibliche* to be suppressed by science? Mrs. Ayrton was one of those who aspired to prove that woman can be as man as an original scientific inquirer. Did she succeed? If we are to frame a psychology of the scientific mind, regarding this as a species apart, we must carefully note and analyse the doings of such as she. I have but small qualification for the office, yet as she was my colleague's wife and we often met and were in fair sympathy, I was able to take notice of her idiosyncrasies and of the conditions under which she was placed.

Ayrton and I met originally in the autumn of 1879, when we were appointed the first two professors of the City and Guilds Institute and set the ball of technical education rolling in London; the ball rolled well and proved to be fissiparous but no one of the small band who gave it shape in the City and West End ever received the slightest recognition from the Guilds, their masters—and most of these have committed *hari-kari* as concerted workers in education. A strange world is ours and if we worked otherwise than for the sake of working, we should do little.

Ayrton had a peculiar experience: his then (first) wife—his cousin, Mathilda Chaplin—was a woman who had acquired merit in the cause of women's rights, as she was one of the three, I believe, over whom the fight first raged in Edinburgh whether women should be admitted to the study of medicine. When I met her, her health was more than failing. She was an ethereal being, a woman of infinite charm of manner but above the world—a mature Melisande; indeed, when I first heard Debussy's opera her memory was recalled to me by the peculiar rhythm and tone of its melody. Her daughter, Mrs. Zangwill, has inherited not a few of her mother's characteristics—especially her charm of voice. Her chief occupation was novel-reading, from penny-dreadfuls upwards, in which she ran a caucus race with our erratic friend, John Perry.

Ayrton married his second wife in 1885. If I were to compose an opera with my scientific friends as the characters, I should associate the Melisande theme with the first Mrs. Ayrton; I should not quite know where to place the second musically but it would be near to Brunhilde, as she had much of the vigour of Wotan's masterful daughter and, at least, aspired to be an active companion of scientific heroes—a race far above Wagner's dull and degenerate Teutonic gods, be it said.

Sarah Marks was the daughter of intelligent but poor Jewish parents in Portsmouth. She was a clever child and was early sent to a school in London kept by her paternal aunt, who became Mrs. Hartog; Mr. Hartog was a teacher of French in London. Mrs. Hartog was the mother of Numa Hartog, Philip Hartog and the professor of botany in Cork; also of two daughters, one very clever, a talented painter, who married Dr. Darmstadter of Paris; the other earned her living as a musician. Numa Hartog died early, after a most brilliant university career and seems to have been unusually clever. Mrs. Marks had four undistinguished children, besides Sarah; nothing is known of her parents. Mrs. Ayrton's ability, however,

would seem to have been derived from the mother's side.

At about the age of fifteen, Sarah Marks became acquainted with Madame Bodichon, a well-to-do lady, strong on the women's rights question, who sent her young friend to Girton College, Cambridge. Apparently, she then changed her name to Hertha. She took honours in mathematics. She is credited with the invention, during the period, of a sphygmograph and also of an instrument for rapidly dividing up a line into a number of equal parts. Through Madame Bodichon, she became acquainted with George Eliot and several other people of distinction. In 1884 she entered the Finsbury Technical College. I remember her coming. She not only came but was seen and soon conquered—Ayrton; and they married. As sole issue they had a daughter, who has her father's gift of tongue; she married a Christian, whilst his daughter by his first wife married a Jew. I often told him that he and his wife were an ill-assorted couple: being both enthusiastic and having cognate interests, they constantly worried each other about the work they were doing. He should have had a humdrum wife, "an active, useful sort of person," such as Lady Catherine recommended Mr. Collins to marry, who would have put him into carpet-slippers when he came home, fed him well and led him not to worry either himself or other people, especially other people; then he would have lived a longer and a happier life and done far more effective work, I believe.

Under her husband's inspiration, Mrs. Ayrton soon entered upon the study of the electric arc. Her work is recorded in the book on the subject which she published in 1902, in part a reprint of papers submitted to the Royal and other Societies. She was an indefatigable and skilful worker. Whatever the absolute value of her observations, her husband and his good friend Perry were the last not to make the most of her achievement, so probably the scientific halo with which they and others who fancied that women could be as men surrounded her was overpainted. Most of us thought, at the time, that they were ill advised in preferring her claim to the Royal Society; the nomination came to nothing on legal grounds. She was, however, elected into the Institution of Electrical Engineers and at her death was its only lady member. She also engaged in an inquiry into the formation of sand ripples and this led her, early in the War, when chlorine was first used as poison gas, to develop a fan-device for waving back the fumes. There is little doubt that she took too high a view of the practical value of the invention and was unwarrantably aggrieved at its rejection by the military authorities. She was awarded the Hughes Medal by the Royal Society in 1906.

Mrs. Ayrton was a very striking woman in appearance and of considerable personal charm, full of common sense; this kept her from being a militant suffragist, though she promoted the cause in every possible way. I never saw reason to believe that she was original in any special degree; indeed, I always thought that she was far more subject to her husband's lead than either he or she imagined. Probably she never had a thorough scientific equipment; though a capable worker, she was a complete specialist and had neither the extent nor depth of knowledge, the penetrative faculty, required to give her entire grasp of her subject. Ayrton himself, though a genius, was in no slight measure partial in his interests: by heredity literary and artistic, educated intensively in the classical school, a born actor and therefore a good lecturer and public speaker, impelled into science through contact with Sir William Thomson, he was a worker chiefly at its technical and commercial fringe rather than in its depths: so he was not a good judge of his wife's scientific ability. His partner Perry was the solid member of the firm. In fine, my conclusion is, that *das ewig Weibliche* was in no way overcome in Mrs. Ayrton: nor could we wish that a thing so infinitely precious should be: she was a good woman, despite of her being tinged with the scientific afflatus.

Henry E. Armstrong.

Dr. J. E. Stead, F.R.S.

By the death of Dr. John Edward Stead, on October 31, at the age of seventy-two, Great Britain has lost one of its most famous metallurgists, a man who played a very honourable and a leading part in the development of scientific metallurgy, and is not unworthy to be ranked with the great names of John Percy, Lowthian Bell, and Roberts-Austen.

Dr. Stead was born in 1851 and was a younger brother of the late W. T. Stead. After the usual period spent at school, he was for a time an evening student at the Owens College, Manchester, in the early days at Quay Street. From there he passed to a steel works in the Middlesbrough district, where he served his apprenticeship on the practical side of iron and steel smelting, but he was only nineteen when he entered the laboratories of Pattinson, a consulting chemist and metallurgist in the district. Later the two men entered into partnership under the title of Pattinson and Stead, and he remained identified with the firm for the remainder of his life, a period of about fifty-two years in all. He became one of the best-known analysts in the north of England, and one can only conjecture how many large contracts were signed on the basis of Stead's analyses.

An incident related to the writer some twenty years ago by Dr. Stead will give some idea of how this man, with a very slight amount of what would be termed academic training, rose to a position of great power and trust, not merely in the Cleveland district where he lived, but also in the iron and steel industry of the whole country. He found on one occasion, in the early days of his association with Pattinson, that he had sent an incorrect analysis to one of the firm's clients. Without hesitation he wrote to explain that he had made a mistake and substituted the correct figures. The client in question was exceedingly angry, not because he had received an incorrect analysis, but because Stead had admitted that he had made a mistake. Apparently this is a serious matter where business is concerned. Stead retorted, "If I was unwilling to admit that I made mistakes, you would never know whether a result I sent you was correct or not." This was a new point of view, and the client was so much impressed by it, that he sent all his

analyses to Stead in the future, after having previously threatened to withdraw his custom.

It is not as an analyst, however, that Stead rose to fame. He was naturally of an inquiring mind, eager to discover truth in any form that he could, and in the course of forty-six years he published at least eighty papers before seventeen institutions, in which he covered a range of subjects in the metallurgy of iron and steel, such as few, if any other, men have attempted. If he could be said to have made one subject rather than another peculiarly his own, it was the influence of phosphorus on iron. This was perfectly natural, for the Cleveland ores are phosphoric, and phosphorus, at any rate in association with carbon, is the worst enemy of steel. It is not generally known that Stead played a very important part in the early days of the development of the Thomas-Gilchrist basic Bessemer process for the dephosphorisation of phosphoric iron ores, a process which enabled Germany to become the second largest producer of steel in the world, with all the consequences that have followed. One of the essential features of the process is the so-called "afterblow," when the blowing of air through the converter is continued after the complete removal of carbon. Stead was the first to advance the correct explanation of what takes place, namely, that phosphorus is removed during this period, but not until then, by iron oxide. Thomas and Gilchrist challenged this explanation and only accepted it in the following year when they obtained letters patent for the "afterblow."

Stead was one of the first men in Great Britain to realise the importance of Sorby's investigations, which led to the foundation of metallography as a science. With true vision he saw that here was a new experimental weapon for investigating the properties of all metals and alloys, and the majority of his investigations have lain in this field. Within the limits of this article it is impossible to give any adequate idea of their scope and variety, but this, at all events, may be said, that his contributions to our knowledge of the crystallisation phenomena observed in iron and steel, and the segregatory and migratory habits of solids in alloys, were such that he became one of the chief authorities in the world on these subjects. He made important contributions to the technique of microscopic metallography, and his method of heat-tinting specimens by oxidation became an accepted method for the micro-analysis of cast iron.

Living as he did to the age of seventy-two, it would have been very surprising if honours had not come to Stead. He became a member of council of the Iron and Steel Institute in 1895, a vice-president in 1910, and president in 1920. He received the Bessemer medal of the Institute in 1901. In 1910 he was president of Section B of the British Association at Sheffield. He also filled the office of president of the Cleveland Institution of Engineers. The majority of his papers were published before these two Institutions. He was given honorary doctorates of the Universities of Manchester, Leeds, and Sheffield, and he had been for twenty years a fellow of the Royal Society.

No man revealed himself more characteristically in his papers than Stead. He had a generous and ardent mind, and he pursued the search for truth with a single-mindedness which was an inspiration to all who knew him. The willingness to admit that he was wrong when he was wrong, which is not so common a virtue as it should be, and to which attention has already been directed, made him an ideal opponent in scientific controversy. Characteristically enough, he was particularly generous to young workers in the field of metallurgy, imbuing them with something of his knowledge and enthusiasm, and encouraging them by generous praise. The writer recalls several such occasions in his own experience. During the last eighteen months Stead had been forced to live in retirement and indeed had become a physical invalid, but his mind remained clear and active up to the time of his death. He leaves behind him the memory of a life splendidly lived, which those who were privileged to know him will always cherish.

H. C. H. CARPENTER.

M. MAURICE LEBLANC.

BY the death of Maurice Leblanc on October 27, the world loses one of its greatest engineers. He had striking originality. In conjunction with M. Hutin, he invented the *amortisseur* or damping coil, which when applied to alternators enables them to run steadily in parallel. He also perfected the method of converting induction motors into generators by driving their rotors at speeds greater than synchronism by prime movers. He ran them in parallel, the frequency of the supply depending only on a small alternator in the supply circuit, the function of which he compared with that of a *chef d'orchestre*. In recent years he devised a remarkable system for high-speed electric traction. The energy is communicated to the moving train without rubbing contacts by means of magnetic induction. He proposed to utilise alternating currents having frequencies of 20,000, the current being carried over the track by a series of tubular condensers adjusted to resonance. The currents in the locomotive circuits are converted to low frequency by thermionic valves. They then operate induction motors as in ordinary traction systems.

In the very difficult years 1912–1914 Leblanc filled the post of president of the International Electrotechnical Commission with universal acceptance. His speech when resigning the office of president at the London meeting in 1919 was a powerful plea for nations and individuals to give up working exclusively for selfish ends. The lack of this in the past had led to the greatest catastrophe of all time. "From henceforth only productive work will be deemed honourable." He was elected an honorary member of the Institution of Electrical Engineers in 1915. His high ideals and singleness of purpose made friends for him in every country of the world.

A. R.

WE regret to announce the following deaths:

Mr. Thomas Pridgin Teale, F.R.S., the eminent surgeon and sanitarian, on November 13, aged ninety-two.

Dr. Boris Sidis, of the Sidis Psychotherapeutic Institute, Portsmouth, New Hampshire, known for his work on the psychology of suggestion and mental dissociation, on October 25, aged fifty-six.

Current Topics and Events.

THE Western Galleries of the Science Museum, South Kensington, which for nearly half a century have contained the valuable Science Collections of the Museum, were closed to the public on September 17. These galleries have now been vacated, and the constructional and other work (gun foundations, re-decoration, etc.) considered by the Government to be necessary to make the galleries fit to house the collections and staff of the Imperial War Museum (created a few years ago, and now at the Crystal Palace) is already well in hand. The Science Collections have been transferred to three unfinished galleries in the eastern block of the new Science Museum building (see NATURE, June 30, p. 895), which were not vacated by the Post Office Savings Bank department until towards the end of September. The total floor-area available in these galleries is only about two-thirds that in the Western Galleries, which were already much overcrowded; but by using two of the new galleries as store-rooms, in which objects are packed very closely together, it has been possible to arrange objects in the third gallery under conditions which allowed this gallery to be open to the public from November 11. Here are shown groups of objects selected from the sections illustrating astronomy, surveying, meteorology, chemistry, optics, sound, and botany. The remaining objects in these sections, and all the objects in the sections illustrating mathematics, general physics, photography, kinematography, heat, geophysics, geology, geography, and oceanography—forming altogether about eighty per cent. of the Science Collections—are thus stored away, and cannot be placed on exhibition again until further space becomes available. The progress made during recent years with the fine new buildings of the National Science Museums of Germany and Austria, at Munich and Vienna respectively, affords a significant contrast to the above.

THE Council of the Trade Marks, Patents, and Designs Federation, Ltd., recently circulated a questionnaire in relation to trade marks, patents, and designs prepared by the International Chamber of Commerce to a number of societies interested in these matters. This questionnaire was drawn up with the object of ascertaining the directions in which modifications and amendments were desirable, from the British point of view, in the International Convention for the Protection of Industrial Property (Treaties Series, No. 8 (1913). Cmd. 6805. H.M.S.O. Price 6*d*. net.), signed at Washington on June 2, 1911 (State Papers, vol. 104, p. 116). A meeting of the representatives of some twenty of the societies consulted was held at Lever House, Blackfriars, on November 23. The questionnaire was discussed, and it was recommended, *inter alia*, that (1) a clause should be inserted in the Convention abolishing revocation of patent rights either for non-working or for abuse of monopoly, but permitting each country at its discretion to grant compulsory licences in such cases; (2) provision should be made for establishing in all Convention countries a uniform period of duration for patents, and renewal fees should be paid at agreed intervals of time and be based on a sliding scale system of progressively increasing payments; (3) there should be uniform provisions governing the use of an invention on vessels sailing under the flag of one of the States which has adhered to the Convention; (4) there should be provision for registration in a public register kept by the competent administration of each country of all assignments and licences affecting the legal proprietorship of patent rights; (5) steps should be taken to secure a greater degree of uniformity in the regulations at present in force in the various Convention countries with respect to the procedure to be followed on applications for the grant of letters patent. It was further agreed that it was neither desirable nor practicable to insist upon the institution in all Convention countries of a system of preliminary search of patent applications, but it was desirable that any party interested should have the right, prior to the grant of any patent, to institute opposition proceedings based on all prior publications or public users of the invention of which he has knowledge.

THE British Meteorological Office announces an mportant step towards supplying ships with information regarding the existing weather around the British coasts and forecasts for the seas adjacent to the British Isles. On January 1 a new series of broadcast wireless messages will be issued from the Air Ministry Station at 9 A.M. and 8 P.M. daily. Each message will contain the actual observations of wind, weather, pressure, barometric tendency, and visibility at ten stations on the British coasts taken only two hours before the broadcast issue. The messages will also give a general inference of weather conditions and forecasts for twelve hours for eleven sea districts; at the end a further outlook will be given when possible. The code and full particulars may be found in the Board of Trade notices to mariners for November or in the *Marine Observer*, a monthly magazine to be published by His Majesty's Stationery Office from the beginning of 1924.

IN an address delivered before the Scientific and Technical Circle of the Institute of Journalists on November 20, Sir Richard Gregory, the chairman, discussed the relation of science to progress. In his opening remarks he recalled that Ruskin in his "Crown of Wild Olive," George Gissing in his "Private Papers of Henry Ryecroft," and many other writers had associated science with agencies of death or denounced it as detrimental to social culture. This, however, is a narrow view, and it is futile to rail against the progress of science or attempt to prevent it. We are now on the threshold of developments by which forces may be unloosed and powers acquired far beyond those hitherto known to man. Science is no more responsible for the horrors of the War than for soul-destroying industrial conditions. Scientific discoveries may be used for the benefit of mankind or be applied to base uses. Thus

chlorine, the first poison-gas used in the War, had for more than a hundred years previously been used as a bleaching agent. Nitre, though a constituent of explosives, has been used in fertilisers with such success that the average yield of wheat per acre in England is now 30 bushels instead of 20 bushels as in the seventeenth century. The vast development in the production and export of cotton piece-goods is due to science and invention. China has vast stores of anthracite coal and other minerals, but because of the lack of scientific knowledge and ability to exploit these resources, most of the people of that country live in comparative poverty. It is impossible to foresee the applications of discoveries. Minerals which a few years ago were scientific curiosities, rare gases like neon, argon, and helium, have now uses unsuspected by the discoverers. It is our duty to see that the powers which science gives to the human race should be used for noble and spiritual purposes, so that they may be a blessing to mankind instead of a curse.

The next Congress of the Royal Sanitary Institute will be held at Liverpool on July 14-19, 1924, by invitation of the Lord Mayor and City Council.

Sir Arthur Keith will deliver the Thomas Vicary lecture of the Royal College of Surgeons of England in the theatre of the College in Lincoln's Inn Fields on Friday, December 7, at 5 o'clock. The subject of the lecture will be "The Life and Times of William Clift, First Conservator."

At the November meeting of the Royal Statistical Society, the Frances Wood Memorial prize, value 30*l.*, which is offered biennially for the best investigation of any problem dealing with the economic or social conditions of the wage-earning classes, was awarded to Miss E. J. M. Haynes, of Oxford, for an essay on human power in the English pottery industry.

The Liverpool Psychological Society has been inaugurated under the presidency of Prof. Alexander Mair of the University of Liverpool, supported by Dr. Betts Taplin as vice-president and an influential committee. The Society intends to pursue the systematic investigation of the recent developments of the science. Further information can be obtained from the secretary of the Society, the University, Liverpool.

A junior assistant is required by the Royal Aircraft Establishment, South Farnborough, Hants, for aerodynamic research in wind tunnels. Candidates for the post must possess a good knowledge of physics and applied mathematics and an honours degree in natural science or engineering. Applications, marked Ref. A. 23, should be sent to the Superintendent of the Royal Aircraft Establishment.

Applications are invited by the Queensland Government for the position of Director of the Laboratory of Microbiology and Pathology of the Department of Public Health, Brisbane. Candidates must hold a diploma in public health and have had recent special laboratory experience in microbiology. The Agent-General for Queensland, 409 Strand, W.C.2, will supply further information respecting the post. The latest date for the receipt of applications is December 17.

An Inspector is required by the Ministry of Agriculture and Fisheries in connexion with agricultural and horticultural education and research. Candidates must have taken a University or Agricultural College course in science or agriculture and have had special training in the science and practice of poultry and small livestock keeping—including goats and rabbits. Forms of application, etc., may be had from the Secretary of the Ministry, 10 Whitehall Place, S.W.1. They must be returned by, at latest, December 8.

The Committee of the Christie Hospital, Manchester, is offering a prize of 300*l.* for cancer research. The aim is to stimulate isolated work, particularly that already in progress, apart from the research schemes of cancer research institutions; for the Committee thinks that notable increase in the knowledge of cancer may come from an individual worker as well as from a team of men investigating the subject systematically. At the same time, the Committee intends to keep up its own research work at the University of Manchester. Since advances may be expected from sciences allied to medicine, the conditions attached to the prize are very wide. Candidates must be qualified in medicine, or in science cognate to medicine, and must produce evidence of original research on cancer done or projected. All documents must be submitted in English, but nationality is no condition of the award. Applications must reach the chairman of the Medical Board, Christie Hospital, Manchester, not later than December 31, 1924.

In June the Canadian explorer, Dr. V. Stefansson, directed the attention of the Textile Department of the University of Leeds to the wool of the Ovibos (musk ox), which is capable of being bred in large numbers in the arctic zone of Canada and might be a considerable asset to the Dominion. The wool, of a natural brown colour, is hidden by an overgrowth of long hair, which is troublesome in manufacture. The first specimen woven in the Department was brought to the notice of the King at the time of the meeting of the Imperial Conference in October. Samples have been dyed successfully, and further experiments are in progress to eliminate the long hairs. The Clothworkers' Company of London, to whom the University is so greatly indebted in many ways, and particularly for the building, equipment, and endowment of the Textile Industries and Dyeing Departments, is showing a keen interest in these important experiments.

The winter scientific reunion of the Natural History Museum Staff Association was held in the Board Room of the Museum on November 14, and attracted a large attendance of the staff and other workers in natural history. Many, varied, and interesting specimens were exhibited, among which may be mentioned: Fossil Arachnida from the Rhynie Chert, Old Red Sandstone, Aberdeenshire (the oldest recorded instance

of Arachnida); examples of sex dimorphism in cuttle-fish; the second and third cervical vertebræ of a Sibbald's rorqual (revealing the exceptional size of the original whale); cast of the skull of *Baluchitherium Grangeri* from the Miocene, Central Mongolia; examples illustrating the germination of the coco-nut; selection of minerals collected by Mr. F. N. Ashcroft from Cavradi and Sedrun, Switzerland; example of a fish, *Gigantura chuni*, which had swallowed another, Chauliodus, double its length; a series of reproductions of remarkable photographs of African big game. The Cambridge and Paul Instrument Company demonstrated microtomes manufactured by that firm.

Dr. S. Judd Lewis has been awarded the gold research medal of the Worshipful Company of Dyers, on the recommendation of the Society of Dyers and Colourists, for his work on the quantitative determination of the fluorescent power of various forms of cellulose and its derivatives, published in the Journal of the Society. It has been shown that the form and dimensions of the fluorescence curve, having as its co-ordinates the wave-length and fluorescent power per cent. relative to a standard paper, are related to the chemical constitution of the substance. The curves for pure cellulose, hydrocellulose, oxycellulose, cellulose acetate, etc., as well as those for various sugars, are all characteristic, with peculiarities in common for those substances of similar structure. The physical condition of the material has very little effect on the results. It is anticipated that this new method, which is conducted photographically, will prove useful in throwing light on the constitution of opaque solid substances in much the same way as absorption spectroscopy is applied to the investigation of transparent fluids.

Mr. F. Edwards, 83 High Street, Marylebone, has just circulated Catalogue No. 452 of nearly 1400 books of voyages, travels, exploration, and sport. Among the works listed are the first edition of Hakluyt's "Navigations," etc., a complete set of the second series, to 1922, of the Hakluyt Society Publications, and a set of the Journal and Proceedings of the Royal Geographical Society to 1919. The same bookseller has also sent us a selected list of books, engravings, and maps relating to West Africa.

Among the new announcements of Messrs. Macmillan and Co., Ltd., to which attention has not hitherto been directed in Nature, are the following: The Autobiography of Sir Archibald Geikie; "A Glimpse of the Natives of Central Australia," by Dr. G. Horne and G. Aiston, which will deal with the country, the habits, customs, and beliefs of the Wonkonguru and their neighbours (much of the information has been collected at first-hand from the natives); and the collected works on Economics of Prof. F. Y. Edgeworth, in 3 vols., with introductions to the various sections by the author.

Our Astronomical Column.

Reinmuth's Cometary Object.—After considerable delay, owing to its faintness, a third photographic observation of this object was obtained by Graff and Baade at Bergedorf. Stracke has deduced the following elliptical elements:

T	1923, Nov. 28·92 G.M.T.
ω	182° 58′ 19″
Ω	229 17 10
i	16 18 4
e	0·4701
log q	0·1621
Period	4·537 years.

The Bergedorf plate showed no nebulosity, so the object may be a minor planet, of the type of Aethra. Its perihelion is well within the orbit of Mars. Its position at midnight on Dec. 3 is R.A. $1^h\ 47{\cdot}5^m$, N. Decl. 6° 27′; daily motion $+1{\cdot}55^m$, S. 18′.

The Total Solar Eclipse of September 10.—*Popular Astronomy* for October contains a photograph of the corona taken at Lompoc, California, by Mr. Worthington. The scale is too small to show much detail, but the outline conforms to the type of sunspot minimum.

The Sproul Observatory at Durengo, Mexico, the Steward Observatory expedition on the Gulf of California, and the Mexican and German expeditions at Yerbaniz, Berrendo, and Pasage (all in Mexico), all enjoyed good conditions and were able to carry out their programmes. Most of the other parties were partly or wholly clouded out.

Mr. Morgen Brooks ascended a mountain in Catalina Island and obtained some very interesting views of the passage of the shadow on the clouds. He makes the usual remark that light seemed to increase more rapidly than it diminished. This is probably subjective, one's eyes becoming more sensitive during the darkness. He saw no shadow-bands.

A Remarkable Meteoric Procession.—A swarm of light meteors was seen on February 9, 1913, to pass over Canada, the United States, and the Atlantic, the length of the track being several thousands of miles. Prof. W. H. Pickering has made a study of their motion in *Popular Astronomy*, proving that their orbit before encountering the earth cannot have been of a cometary character, but must have been an ellipse not very different from the orbit of the earth itself, to permit the relative velocity to be so small. This would tend to support the view of the late Sir Robert Ball that the slow-moving fireballs were probably ejected from terrestrial volcanoes in the distant past. Their velocity on emerging from proximity to the earth would not be very different from the earth's velocity, and their subsequent orbits would be close to that of the earth.

Prof. Pickering notes that it is quite likely that (with the aid of the moon) some of these bodies may have been captured as satellites of the earth and revolve around it above the atmosphere. When they enter the latter they ultimately descend to the ground.

A Projected French Observatory.—*La Nature* of November 3 states that M. Dina, an engineer, is endowing an important new observatory at Cruseilles in Haute-Savoie. He has recently discussed the plans with General Ferrié and MM. H. Deslandres and A. Danjon. It is expected that a large reflector will be included in the equipment, which will probably be devoted mainly to researches in astrophysics. Meteorology w ll also occupy an important place in the work o the observatory. It may be presumed that the quality of seeing has been already studied at the proposed site, as this is of such vital importance in the case of large aperture instruments.

Research Items.

Red Deer from the Holderness Peat.—Two discoveries of the remains of red deer in the peat of Holderness are recorded by Mr. T. Sheppard in the November issue of the *Naturalist*. The first was found in beds exposed on the shore near Skipsea, East Yorks. The entire skeleton with the exception of a few small bones was recovered and is now exhibited in the Municipal Museum at Hull. The antlers measure 2 ft. 3 in., and 2 ft. 2½ in., one having seven and the other six points. The second discovery was made in the peat on the shore at Withernsea at very low water during the spring tides. Consequently little time was available for excavation and only the antlers were secured. The right antler measured 33 in. in length and 9 in. in diameter at the skull. The left antler was unfortunately broken in the course of excavation and only a part recovered.

Geographical Work in Egypt.—The Ministry of Public Works, Egypt, publishes the report on the work of the Physical Department for the year ending March 31, 1923. In the Hydrological Service, rainfall observations were received from 281 stations in Egypt and surrounding lands, an increase of ten compared with the previous year. The Nile basin is fairly well supplied with stations except Abyssinia, where there are only six. River discharge measurements were taken on all the main branches of the Nile. A discharge station at Nimule, on the borders of the Sudan and Uganda, will give a measure of the amount of water available for storage in Lake Albert which is essential in any project for controlling the waters of that lake. Among numerous other researches it may be noted that experiments were made with hydrogen drift balloons carrying a magnesium flash mixture, in order to connect, by the help of a camera, the European and African triangulations by way of Crete. The Meteorological Service now receives observations from twenty-four stations in Egypt and twenty-nine in the Sudan. A station in the Sinai peninsula at Bir Abu Tif, founded two years ago by a commercial company, was closed.

Flora of the Tibetan Marshes.—The ecologist will find an interesting description of a little-known region in Mr. F. Kingdon Ward's account of the flora of the Tibetan marshes in the Journal of the Royal Horticultural Society, volume 48, parts 2 and 3, issued September 1923. He describes the glaciated limestone plateau east of the Yangtze, a country of wide Alpine valleys and numerous small lakes with frequent lofty escarpments overlooking the rivers running from north to south. This country appears to be magnificently rich in herbaceous alpines, which are unaffected by the seasonal droughts occurring in their non-growing season, while these conditions prevent the vigorous development of woody plants. As opposed to the country to its west, it is a land of primulas rather than of rhododendrons. Mr. Ward's account of the vegetation is none the less interesting because it is written with a special reference to the plants which are of horticultural interest when transferred to the amateur's garden. Many students of rock gardens will be interested by his pertinent remarks, based upon the study of the rock flora in Nature, as to the places where certain plants should appear in the garden. Thus he suggests that plants with translucent flowers, such as a species of Onosma, are intended to grow on a level with the eye so that the light reaches the observer through the petals of the flower, while others, like some of the dwarf Campanulas, are intended to hang downwards from the crevices in the cliff.

Lignite in Nigeria.—The Bulletin of the Imperial Institute, volume 21, No. 2, 1923, contains an important article upon the lignite deposits of Nigeria, which are to be found on both banks of the Niger and seem likely to afford a practicable fuel of special value for boats navigating the Niger. The geological relations of the lignite deposits in the Southern Provinces of Nigeria are discussed and the distribution of the beds indicated so far as it is known. Analyses of the chemical composition of samples from various seams are presented and trials reported of the suitability of the lignite for manufacture into briquettes. A large scale trial of the Nigeria lignite was made by making up a considerable amount of the material into briquettes through the co-operation of a factory in Saxony; these bricks were then used in locomotives on the railways in both the northern and southern provinces of Nigeria with results that suggest that they will provide quite a satisfactory fuel. In view of the cost of imported coal in British West Africa the subject would seem to be of considerable economic importance.

New Oligocene Toothed Cetacean from South Carolina.—Mr. R. Kellogg figures and describes (Smithsonian Miscellaneous Collections, vol. lxxvi. No. 7) an apparently new toothed Cetacean from beds probably of Oligocene age in Berkeley County, South Carolina. The fossil consists of a skull 371 mm. (=14½ in.) in length. In some respects it resembles Agorophius and Archæodelphis, but is considered to represent a new genus and species and has been named *Xenorophus sloanii*.

Italian Earthquakes in 1911.—For the first time since the War, the Central Office of Meteorology and Geodynamics at Rome has issued its "Notices of Earthquakes observed in Italy." The present volume of nearly 600 pages deals with the earthquakes of the year 1911 and forms an appendix to vol. xviii. (1914) of the Bollettino of the Italian Seismological Society. One advantage of late publication is that the results obtained at foreign observatories can be incorporated. The total number of earthquakes recorded in 1911 is about 800, of which one-fifth were of external origin. Of the latter, one in every three is described as a "distant earthquake," the position of its origin being apparently undetermined.

The Cheiropterygium in Amphibia.—Cope's genus Eryops, an early Labyrinthodont from the Permian of Texas and New Mexico, has been much discussed; but new light is now shed on it by a paper on its carpus, by W. K. Gregory, R. W. Miner, and G. K. Noble (Bull. Amer. Museum of Nat. Hist., vol. 48, p. 279, Oct. 17, 1923). The authors point to the primitive characters revealed by their research, and come to the far-reaching conclusion that, while all known fossil and existing amphibia have four digits in the manus, the most primitive forms had "a prepollex, five digits, and a postminimus" in the hand and similar features following a prehallux in the foot. The cheiropterygium was thus at least seven-rayed, with a tendency to reduction in the two marginal rays. It is pertinent to the recent discussion in Nature as to the spelling of names derived from Greek that "cheiropterygium" in this paper is not only docked of its first "i," but, when broken at the end of a line, has the hyphen placed between the "p" and the "t."

Coral-reefs and Coastal Platforms.—The papers on coral-reefs recently read by W. M. Davis before the National Academy of Sciences, Washington, D.C., and

referred to in NATURE (vol. 112, p. 460), have now been printed in the Proceedings of the Academy, vol. 9, pp. 292 and 296. The first deals with the marginal belts of coral seas, and it is pointed out that platforms of low-level abrasion are not known in association with the islands in the cooler zones of the Pacific region, while their depth below sea-level is not so uniform where they do occur as to satisfy Daly's theory of glacial control. If we accept glacial control, as Davis is quite willing to do, the evidence for subsidences of various degrees of magnitude, as put forward by Darwin, remains unimpaired. The second paper deals with the argument based on the uniformity of depth of the lagoons within adjacent atolls, and the author urges that level floors arise through infilling with detritus, which is spread out evenly by the wash of marine water.

PLANTS OF THE MIDDLE OLD RED SANDSTONE.—R. Kidston and W. H. Lang (Trans. R. Soc. Edin., vol. 53, pt. 2, p. 409, 1923) have investigated and completely described the remains of *Palæopitys Milleri* McNab, a plant originally found by Hugh Miller in beds containing *Coccosteus decipiens* near Cromarty. The authors confirm McNab's observation of bordered pits in the tracheides; but they are unable to decide, in the absence of any evidence as to the fructification, whether the genus should be referred to the gymnosperms or to the pteridophyta. In either case it is probably a distinctly archaic type. The same authors (*ibid.* p. 405) describe, and figure in a photographic plate, an extremely beautiful specimen of a plant with numerous stems spreading radially from a basal region. This was collected by G. Edward, and described by him in 1888. Edward placed it, with his other specimens from Scotland, in the Manchester Museum. Its locality is the Hill of Forss, Waas, Caithness, and it is of Middle Old Red Sandstone age. Sporangia set on short stalks occur; but G. Hickling, when on the staff of the University of Manchester, examined these for spores in vain. The authors now give a name to the plant, *Hicklingia Edwardi*, and seek its affinities in forms from the famous Rhynie cherts. It may be found, indeed, that Hicklingia extends our knowledge of the Rhyniaceæ.

DAILY AND SEASONAL VARIATIONS OF FOG.—The Meteorological Office of the Air Ministry has recently issued a Professional Note, vol. iii., No. 33, by Mr. F. Entwistle, on the above subject. Observations of fog from April 1920 to March 1922, a period of 2 years, were grouped for each month at Croydon, Lympne, Cranwell, and Dungeness for all hours of the day for which observations were made. A temporary increase in fog is shown in the early morning, a maximum being reached between one and two hours after sunrise. The summer maximum occurs about three hours earlier than the winter maximum. London smoke naturally somewhat affects the general visibility at Croydon, being influenced by the direction of the wind. Increase of fog in the early morning is said to be due probably to eddy motion mixing the layers of air near the surface. There is generally less fog during the afternoon, between midday and 6 P.M., than at any other time during daylight. For civil aviation it is considered desirable to arrange early morning services, before the maximum fog intensity is reached, while for ordinary services the middle of the day is the best time. In the winter season the larger proportion of slight fogs at Croydon are doubtless due to town influence. The thick fogs at Lympne are due chiefly to low cloud caused mainly by winds between south to south-west, so that the high ground of the North and South Downs is enveloped. The small amount of fog in winter at Dungeness seems to suggest that the best position for an aerodrome in winter is on the coast near sea level. In the summer months thick fog is frequent at Lympne and Dungeness; at Dungeness it is chiefly sea fog caused by the relatively warm air from off the land passing over the cooler sea.

FORMATION OF OZONE IN FLAMES.—Prof. Manchot, of Munich, communicated to the autumn congress of German Chemists at Jena a paper on the formation of ozone in flames. Parts of the flame which have a temperature of 750° C. only contain ozone, as can be proved by the silver reaction. The formation of ozone does not depend on the nature of the combustible gas, ozone being formed with hydrogen, carbon monoxide, methane, acetylene, cyanogen, etc. A flame of oxygen and hydrogen gas of 1300°-1900° C. contains about 0·1 per cent. of ozone, one of acetylene and oxygen of 2100° C. about 1 per cent. The latter blackens silver as if it were covered with soot. The thermal formation of ozone, and also the formation from hydrogen peroxide, are not possible, since ozone is also formed within a flame of perfectly dry carbon monoxide. It is probable that the ozone is formed by the action of electrons.

STANDARDISING PIEZO-ELECTRIC APPARATUS.—The extensive use of the piezo-electric properties of crystals in the measurement of transient pressures such as those due to an explosion makes it necessary to inquire into the validity of the method used to standardise the apparatus. It has generally been considered sufficient to apply a steady known pressure to the crystal and to note the effect. In a short paper in the November issue of the *Philosophical Magazine*, Dr. D. A. Keys, of the McGill University, Montreal, points out that as the standardisation experiment is an isothermal and the ordinary use an adiabatic one, there may be a difference in the piezo-electric constant of the crystal in the two cases. He examines this possibility in the case of tourmaline and comes to the conclusion that for that crystal the difference between the isothermal and adiabatic constants is only ½ per cent.

CHANGES IN CRYSTALLINE STRUCTURE DUE TO TEMPERATURE.—Describing a simple arrangement for showing the alteration in the appearance, under the microscope, of a polished etched metal plate when heated, Herr H. Vogel, in the *Zeitschrift für Elektrochemie*, July 1, 1923, makes the following assumption as to the behaviour of the crystallites, of which the metal is built up. If two crystallites touch one another, the distance between the atoms in the boundary plane of one of them will, in general, be greater than in that of the other, and the forces holding the atoms in these respective planes will be different. When the metal is heated the first crystal will grow at the expense of the other, and as this takes place throughout the metal, the average size of the crystallites increases. It is possible for a crystallite to grow on one side and be consumed by another crystallite on another, so that the relation between the initial and the final structure may be complicated. The distance between atoms in the octohedron plane is greater than in the cube surfaces of the lattice, and it is still greater in the rhombic dodecahedron surfaces; thus when two crystals *A* and *C* touch with surfaces of the first and third kind, crystal *A* grows; while when *A* and *B* touch with surfaces of the first and second kind, crystal *B* grows and *A* is consumed.

CHEMICAL ANALYSIS BY X-RAYS.—In a paper read before the Deutschen Bunsen-Gesellschaft, Dr. D. Coster shows that the relations between the X-ray spectra of the different elements are so simple that, in

some respects, they are more useful for purposes of chemical analysis than ordinary luminous spectra (*Zeitschrift für Elektrochemie*, Aug. 1, 1923). An important advantage is the fact that the X-ray spectrum of an element is quite independent of the nature of the compound containing it which is examined. It is easy to detect the presence of an element when only 1 per cent. is present in a mixture of which not more than 1 mg. is available. Certain precautions are necessary in examining the X-ray spectra; although the number of lines for each element is comparatively limited, recent observations have shown the existence of a number of weaker lines; in addition to this, with the high voltages now generally used, not only the spectrum of the first order, but also those of higher orders appear. Slight impurities in the material of the anticathode, and in the substance under examination, also give their lines, so that there are often various possibilities to be considered before a given line can be explained. Not only the wave-length, but also the typical appearance of the suspected lines must be considered, as well as their relative intensity. By measuring photometrically the intensity of the spectral lines it is possible, in some cases, to obtain a quantitative estimate of the amount of an element present in a mixture. The method was used by Hevesy and the author in determining the amount of hafnium in zirconium minerals, and in investigating the chemical properties of the new element.

Magnetic Records of the British Isles.—The British Meteorological and Magnetic Year Book for 1920, published by the Meteorological Office, gives particulars of the diurnal variation of the principal meteorological elements at the Aberdeen, Eskdalemuir, Valencia, and Kew Observatories, with rainfall and sunshine data at Falmouth. The major portion of the volume, however, is devoted to terrestrial magnetism, especially at Eskdalemuir. Two pages are devoted to the diurnal variation of the potential gradient of atmospheric electricity. The results for Kew are based on 10 selected days a month free from negative potential. For Eskdalemuir there are two sets of data, the first derived like the Kew data from days free from negative potential, the second from days when negative potential occurred, although they were comparatively quiet. Taking the first class of days, the mean value of potential gradient at Eskdalemuir for summer (May to August) is practically identical with that at Kew. In the other seasons the Kew value is the greater, the excess being 9 per cent. for the equinoctial and 45 for the winter season. The difference is thus greatest in the months when fog—a recognised source of high potential—is most prevalent in the Thames valley. In addition to the regular tables of hourly values and diurnal inequalities of terrestrial magnetism, there is a discussion by Dr. Crichton Mitchell of different measures of daily magnetic activity at Eskdalemuir. All his criteria make 1920 a quieter year than 1919, and the same conclusion is drawn from the Kew data. There was, however, an exceptionally violent magnetic storm on March 22-23, 1920, during which the range of declination at Kew exceeded 2°. According to the table on p. 47, the fall of westerly declination from 1919 to 1920 was 9·9′ at Kew, 9·3′ at Valencia, and 9·0′ at Eskdalemuir. Inclination appeared to be practically stationary, while horizontal force showed a slight fall: 7γ at Eskdalemuir, 6γ at Kew, and 2γ at Valencia.

Photographic Blackening and Coloured Light.—The second number (August) of the Bulletin of the Kiryu Technical College, Japan, consists of a lengthy and copiously illustrated paper by Tadaroku Ōtashiro on "The Relation between the Photographic Blackening and the Wave-length of Light." The author aims at expressing the blackening as a function of wave-length. For this purpose, different portions of a plate were exposed to different monochromatic lights of equal intensity, and in other cases the wave-length was kept constant and the intensity varied. Ordinary, orthochromatic, panchromatic, and ordinary plates "dyed" (bathed) with solutions of erythrosin, cyanin, and pinacyanol were employed. The author theoretically determines from the photoelectric viewpoint the actual relation between the blackening and the wave-length of the incident light, intensity being constant, and experimentally confirms it. "The general form of the function is quite independent of the kinds of plates, the strength of sensitising solutions, the time of bathing plates in a sensitising solution, the time of washing after bathing, the developers and the temperature during the time of development." The equation includes a "solarisation factor," and it is shown that there are "two maxima and one minimum effect of blackening on the continuous exposure to the most effective light . . . and the first maximum corresponds to the end of the period of over-exposure defined by Hurter and Driffield." He shows that there is a definite relation between the blackening and the strength of any dye solution. The author comes to other interesting conclusions, especially with regard to multiple exposures, and concludes "that the change when a plate has been acted on by white light should be essentially the same as that when the plate has been exposed to the most effective monochromatic rays of light."

Analysis of Coal.—The Fuel Research Board of the Department of Scientific and Industrial Research has issued through H.M. Stationery Office (1*s*. 6*d*. net), Pamphlet No. 2 on the "Physical and Chemical Survey of the National Coal Resources," consisting of an interim report on "Methods of Analysis of Coal." The Board has always had in view the physical and chemical survey of coal seams in the different mining areas—a task of great magnitude—and the policy pursued has been to encourage the formation of local committees of persons interested in the different coal fields to which the execution of the survey could be delegated. The results of such a survey would be greatly depreciated in value unless unity of analytical procedure were ensured, and accordingly the Board asked a committee on sampling and analysis of coal, presided over by Prof. T. Gray, to tabulate a scheme of coal analysis which could be uniformly adopted in the survey. This pamphlet records their efforts. The importance is even wider, for most commercial coal testing is confined to the proximate analysis—essentially empirical and demanding uniformity of practice if discrepant analyses and commercial friction are to be avoided. There is no doubt as to the value of the report in this direction. Although nothing of the kind has been done previously in Great Britain, the field has already been tilled by American fuel chemists—so well that in many cases the committee has been able to adopt their specification without serious modification. This applies particularly to the proximate analysis, and it is likely for that reason that many will find no difficulty in adopting the committee's recommendation. Several special and less common methods of coal assay and analysis are included which will add to the usefulness of the pamphlet. A statement of the permissible analytical error is sometimes given, and forms a welcome inclusion. In suggesting a form of report the committee employs a precision of stating results not quite consistent with its own tolerances. The important question of sampling is reserved to a second report.

School Geography.[1]

Among the valuable reports presented by committees of the British Association at the recent meeting at Liverpool was one on the teaching of geography. The committee included representatives of the two Sections of Geography and Educational Science, and was appointed to formulate suggestions for a syllabus for the teaching of geography both to matriculation standard and in advanced courses, to report upon the present position of the geographical training of teachers and to make recommendations thereon, and to report upon the practical working of Regulations issued by the Board of Education affecting the position of geography in training colleges and secondary schools.

That such a task was pressing, all who have the interests of secondary education at heart will readily admit, and it was well that such an independent body as a committee of the British Association should have undertaken it, for the report shows that the matter demanded urgent consideration and considered judgment. The committee consulted with heads of schools, teachers of geography, examination boards, and universities, and the report is full of suggestions expressed with marked clarity and cogency.

There can be no doubt that a reconstruction of the method and content of geography teaching along the lines of this report is a matter of urgency. The world of to-day is fundamentally different from the world of twenty years ago—or indeed of ten years ago. Life is much more complicated: not only is man more dependent for his social well-being on the activities of a vastly wider world, but his immediate social environment is a complex that requires for its comprehension a degree of reasoning power and scientific knowledge that the school curriculum of a few decades back failed to give. The study of classical literature may give one a deep insight into the life and thought of intellectual giants of the past, but the most pressing need of modern education is a curriculum that will bring before the pupil vividly, and in logical order, the controlling factors that are shaping and giving colour to the social world in which he has to live, and enable him to understand his environment, adjust himself to it, and adjust it to himself. "Geography as ordinarily understood," says the Report, "deals with the world of to-day: it occupies a special position in the study of human conditions at present obtaining in the various parts of the earth and the tendency of the changes taking place therein." Geography, therefore, must take a prominent position in any modern scheme of humane studies. Huxley spoke and wrote strenuously for a curriculum more fitted to help a citizen through the increasingly complicated life that he had to lead (it was the age of scientific discoveries), and his arguments hold with increased force to-day.

One charge that has been laid at the door of modern education is that the teaching of science, history, etc., is formal rather than human, that the courses maintain steady paths parallel to each other without converging at any point. What is wanted is a "core" subject which draws on the others for its facts, co-ordinates them, and thus, by correlation, gives each a fuller and richer meaning. This report shows how geography can be made to function as this core subject. Mackinder and Herbertson at Oxford, Lyde and Chisholm in London, demonstrated this new conception of geography twenty years ago, and the rapid strides made in recent years in the methods of geography teaching in secondary schools are due to the efforts of the young teachers whom they primarily inspired.

At the present time geography takes a place in the school curriculum on a level with history, and below that of classics, French, mathematics, and science. That more sympathy with the subject is not forthcoming is due, first, to the lack of trained geography teachers, whose enthusiasm and knowledge would compel greater recognition, and, secondly, to the fact that the inspectors of the Board of Education, being mainly interested in other subjects, have hitherto attached small importance to it.

For the lack of trained geography teachers one has to blame the Board of Education and the universities jointly. If the former had recognised the importance of the subject earlier and pressed for skilled geography teachers, it is reasonable to assume that the Universities would have established honours schools in geography, as they did, in like circumstances, in science and history; conversely, if the universities had taken the lead, the Board of Education would have been forced to give greater recognition to the subject, just as it has recently been induced to institute a geography group in advanced courses for secondary schools, through pressure from the council of the British Association.

That the geography group will justify its inclusion in the advanced course there can be no doubt, and when one considers the comparative merits of other subjects as a training for life and citizenship one wonders why its inclusion has been so long delayed. At the moment, however, the total lack of geographical scholarships at the universities is a factor that will operate very strongly against a pupil's choice of geography in the advanced course. A boy destined for a professional career to whom the other subject groups are perhaps more useful as a preliminary training for his university course, will naturally make his selection from them, the quantity of scholarships being a strong determining factor. The British Association might usefully direct its attention to this aspect of the problem.

On the other hand, the geography group presents attractions that should more than counterbalance this drawback. To begin with, parents whose boys are destined for city careers—clerical, secretarial, or commercial—have hitherto failed to see, and very naturally, how a two-years post-matriculation course in one of the existing subject-groups can help their sons in a degree at all commensurate with the expenditure of time and money involved. Added to that, many firms prefer to engage youths at the earlier age, and parents with sons of eighteen years have a difficulty in placing them. There is, however, a growing demand for young men who can produce evidence of specialised training for business life—a training, by the way, which so far only private institutions have endeavoured to provide, albeit fairly adequately and remuneratively. In the syllabuses for these examinations—Institute of Secretaries, etc.—geography occupies an important position, and it is also an important subject-group in the course for the B.Com. and B.Sc. (Econ.) degrees which represent the hall-mark, as it were, of vocational training for business life. For these examinations, the geography group is clearly the most useful, and cannot fail to prove attractive.

On turning to the Report itself one has to admit that

[1] Geography Teaching. Report of Committee (Prof. T. P. Nunn, Chairman; Mr. W. H. Barker, Secretary; Prof. H. J. Fleure, Mr. C. J. R Howarth, Sir H. J. Mackinder, Prof. J. L. Myres, and Prof. J. F. Unstead, from Section E; Mr. G. H. J. Adlam, Mr. D. Berridge, Mr. C. E. Browne, Sir Richard Gregory, Mr. E. Sharwood Smith, Mr. E. R. Thomas, and Miss P. Wright, from Section L) (British Association, Burlington House, London, W.1.) Price 1s.; 10s. per doz.; 4l. per 100.

any attempt to summarise it must meet with failure: every aspect of the subject is dealt with in all its bearings, and there is scarcely a redundant word. The chapter on the aim and function of geography is particularly illuminating. Stress is laid on the fact that school geography must be the geography of geographers: not the mere learning of geographical data and results, but a training in the geographer's characteristic methods and principles of interpretation, and an assimilation of his characteristic point of view. This, we consider, is a most important statement, and postulates a trained geographer for the success of any geographical scheme.

Proceeding, the Report deals with the stages of school life, and outlines the principles which should guide in the formation of a syllabus of geographical instruction in secondary schools: a detailed syllabus for each year is appended. Stress is laid on the necessity of proceeding psychologically with young children and of adopting a logical order only as riper years are gradually reached. An outline scheme for each stage, including the advanced course, is given, and apart from its merits as a scheme it possesses special value for the teacher because the underlying aim of each step is made abundantly clear. Great importance is attached throughout to the value of direct observational work and to the construction and interpretation of maps and charts. "One important value of geography in education is the opportunity it gives to express thought in diagram and sketch no less than in words." This sentence should be constantly in the mind of every geography teacher. A highly controversial dictum is that formal lessons in physical geography should not precede the advanced course: incidental teaching of most subjects is apt to be disjointed and incoherent, and the experience of many examiners at matriculation proves that geography is no exception to the rule.

The suggestions for a scheme of study in the advanced courses are excellent. Emphasis is laid on the economic conditions of the modern world, and it is suggested that a small area be selected for comprehensive analysis and synthesis. Correlation of the subsidiary subjects is of course taken for granted.

The chapter on the relation of geography to science and history cannot fail to impress upon the most uninformed reader what a tremendous range of knowledge, not only of topographical facts, but of such allied subjects as physics, geology, botany, biology, history, and economics, is demanded of the geography teacher called upon to carry out such a modern geography course. It is pointed out that it is not his duty to teach these subjects; nevertheless, to correlate them he must know them. The Report proceeds to summarise the facilities offered at the universities for the training of geography teachers. Practically all the universities have established honours schools of geography—mostly in the Faculty of Arts—and there is general agreement that the subject of study should include geology, history, and political economy at least to intermediate standard. The number of trained geographers leaving the universities is steadily increasing, and "the result," to quote the Report, "undoubtedly will be not only a more thorough and scientific study of the subject, but a general increase of accurate knowledge of the Empire and the rest of the world, which will affect the everyday life of the community through its economic and political relationships with other countries."

J. Martin.

Transport and its Indebtedness to Science.

In the Engineering Section of the British Association at Liverpool, one whole morning was devoted to the subject of transport, the other sessions being occupied by papers—many of great interest—on very diverse branches of engineering. The president of the Section, Sir Henry Fowler, was chief mechanical engineer of the Midland Railway, and he took as the subject of his address "Transport and its Indebtedness to Science." extracts from which were published in Nature of September 29, p. 474. He was followed by Mr. A. E. Berriman, the chief engineer of the Daimler Co.; Col. O'Brien, the electrical engineer of the L.M.S. Railway; Major-General Sir Sefton Brancker, of the Air Force; and Mr. A. T. Wall, of Messrs. Wall, Maas and Co., naval architects, of Liverpool.

Each speaker dealt with the branch of the subject with which he was specially identified. As the president pointed out, there is probably no city in the world more dependent on transport than Liverpool, and no city which has done such pioneer service in its development. Whether one considers canals, steam railways, electric railways, or motor traffic, one finds that Liverpool was in the forefront of development, and it was a happy thought of the president, a non-academic engineer, engaged in practice, to take as his thesis that progress in all means of transport has been based upon scientific investigation, to predict that this will be even more marked in the future, to insist on the interdependence of science and engineering, and the necessity for the terms scientific and practical being synonymous. In concluding his address Sir Henry said that "one would like to feel that the meetings of the British Association were more generally used as the occasion on which the scientist and the engineer would meet in larger numbers."

Mr. Berriman gave a very valuable review of the position of road transport. He was somewhat scathing in his criticism of the railway companies' lack of faith in the railway principle, as shown by their proposal to operate their own road vehicles for through traffic. He maintained that, since the tractive effort on rails is only 5 lb. per ton against 60 lb. per ton on average roads, it is technically a sheer waste of energy to transport by road between distant points that are rail-connected. Mr. Berriman also dealt with the question of traffic regulation, and maintained that the warning signs on roads have been put up on a wrong principle and are consequently largely disregarded; in his view, every crossing should have a primary and a secondary stream of traffic, the former having priority and not being expected to slow down; drivers on the secondary roads would be warned to go dead slow on approaching a crossing.

Col. O'Brien's paper, as was to be expected, dealt largely with the question of electrification, which is really an economic one; there are no engineering difficulties. "A very slight lowering of rates of interest and in the price of the material required for such electrification is likely to produce a very considerable development in future." "There is no doubt that the electrification of any main line containing gradients of 1 in 300 or greater and averaging over 2 trains per hour in either direction would at least involve no loss of any kind to the company, while the indirect advantage to both the railway company and the electrical industry of the country would be very large."

Sir Sefton Brancker's breezy optimism with regard to aerial transport caused some amusement. He was fortunate in delivering his paper before the news came

through of the London-Manchester air-mail disaster, which occurred on the same day, more especially as he emphasised the safety, comfort, and exhilaration of flying. Under present conditions, he stated, the cost per passenger-mile could not be reduced below 8½ pence, whilst the highest fare obtainable was 6 pence per mile, leaving 2½ pence to be covered by subsidy. Freight costs per ton-mile he placed at 3*s.* 6*d.* to 5*s.* The only difficulty in the way of development, beyond the economic one, is the difficulty and danger of flying under conditions of poor visibility. The economic range for airships is more than 1000 miles, whilst that of aeroplanes is rarely more than 300 miles, hence the two are complementary and should develop together.

In dealing with sea transport, Mr. Wall emphasised the need for scientific research, especially in metallurgy, but he stated that a very hopeful sign for future progress is to be found in the increasing number of scientific experiments on a large scale carried out by shipbuilders and engineers and sometimes by shipowners. "Experience may, and often does, precede the scientific treatment, but progress is much more rapid when science is used to guide experience."

The Future of the Imperial Institute.

A WHITE Paper (Cmd. 1997), issued on November 22, contains the report of the Committee appointed by the Secretary of State for the Colonies to inquire into the affairs of the Imperial Institute, consequent upon financial difficulties, and also the resolutions passed by the Imperial Economic Conference on considering that report. An article commenting upon the recently published report on the work of the Institute appeared in NATURE of November 10, p. 677.

The Committee considers that the collection and dissemination of information in regard to raw materials is the most important work carried out by the Imperial Institute at the present time. It recommends that the Imperial Institute should continue to function at South Kensington as a clearing-house of intelligence and information, equipped with laboratories for the preliminary analysis and investigation of raw materials, and maintaining sample rooms illustrative of Empire raw materials. The collections in the Public Exhibition Galleries, although recognised as possessing educational value, are not regarded as essential to the future work of the Institute, and it is recommended that the collections be discontinued, though the Committee is by no means unanimous on this point, as is shown by a note appended to the report. It is proposed, however, that a representative selection of Empire products should be made for the purpose of a travelling exhibition of an educational character, and that the organisation of travelling exhibitions of the staple products of the Colonies and Protectorates in appropriate trade centres should be considered.

The Committee proposes reforms in the management of the Institute, suggesting that it should be made responsible to the Department of Overseas Trade. After the completion of these reforms, the Committee recommends the amalgamation of the Imperial Mineral Resources Bureau and the Imperial Institute. The annual expenditure of the reformed Institute (including the Imperial Mineral Resources Bureau) is estimated at about 40,000*l.*, to be provided on a contributory basis. Failing the provision of this sum, which is regarded as a condition precedent to the Committee's recommendations, an alternative scheme is proposed to retain the essential functions of the present Institute, *i.e.* of an intelligence and information bureau.

The Committee expresses appreciation of the valuable services rendered by the Director, Prof. W. R. Dunstan, F.R.S., to the Institute and to the Empire during the long period of his connexion with the Institute, and pays a tribute to the work of the technical staff. Prof. Dunstan was appointed Director in 1903, when he had already been for eight years concerned with the work of the Institute.

The report was submitted by H.M. Government to the Imperial Economic Conference, with the proposal that the main scheme of the Committee should be adopted and the necessary funds guaranteed for a term of years. On the recommendation of a Committee appointed by the Conference, under the chairmanship of Lord Salisbury, the main scheme was adopted, subject to certain modifications not affecting the principles involved.

In the *Times* of November 23 it was announced that, in view of the changes in the constitution of the Imperial Institute which have been decided upon, Prof. W. R. Dunstan will resign the directorship of the Institute next month.

University and Educational Intelligence.

BIRMINGHAM.—Mr. Henry Barber, of Culham Court, Henley-on-Thames, who was formerly a solicitor in Birmingham, has given 20,000*l.* for the endowment of a chair of law in the University.

Mr. H. P. Dean has been appointed assistant lecturer in mechanical engineering, and Mr. M. C. Johnson demonstrator in physics.

It is hoped that Prof. F. C. Lea, who has recently resigned the chair of civil engineering on being appointed head of the Engineering Department of the University of Sheffield, will continue to discharge the duties attaching to the chair for the rest of the current session.

CAMBRIDGE.—The degree of Master of Arts, *honoris causa*, is to be conferred upon Mr. J. B. Buxton, professor of animal pathology.

Prof. T. B. Wood has been reappointed by the University as a Member of the Council of the National Institute of Agricultural Botany.

The Frazer lecture is to be delivered by the Rev. John Roscoe on "Immigrants and their Influence in the Lake Region of Central Africa."

A syndicate has been appointed to obtain plans and estimates for extending the School of Agriculture and constructing a building for the Animal Diseases Institute.

GLASGOW.—Prof. W. J. Goudie, James Watt professor of the theory and practice of heat engines, has given 500*l.* to found an "Agnes Rhind" bursary in memory of his mother, for a third-year student of mechanical engineering who has the best class-record in his subject.

Mr. A. Henderson Bishop and his son have offered to the University, for the new Zoological Museum, the great collection of Coleoptera and Lepidoptera made by his late father, Thomas G. Bishop, of Dalmore, Helensburgh. The collection is contained in 18 cabinets enclosing 700 separate boxes, and numbers some thirty or forty thousand specimens. All are beautifully mounted, labelled, systematically arranged, and in perfect condition. The University has had no difficulty in accepting the splendid gift, with the condition that it shall be accessible for consultation by qualified entomologists, whether they belong to the University or not.

The University Court has submitted for the approval of His Majesty in Council an ordinance establishing the new honours degree of B.Sc. in architecture. The course will extend over four years, and the necessary instruction will be furnished partly within the University, and partly in the School of Architecture, conducted under the joint direction of the Royal Technical College and the Glasgow School of Art.

The Court has also, under powers given by a recent Act of Parliament, approved an ordinance for the superannuation and pensioning, under the Federated System for Universities, of principals and professors hereafter appointed. Principals will retire at seventy and professors at sixty-five. Under the System, years of service as assistant or lecturer, in this or other Universities, may be counted as pensionable service by a professor.

LEEDS.—The Hull Education Committee has decided to make a grant of 800*l.* to the University for the financial year 1924–25.

The title of emeritus professor has been conferred upon Dr. Arthur Smithells, who recently retired from the chair of chemistry, on the grounds of intellectual distinction and of long and meritorious service to the University.

LONDON.—Mr. W. E. Le Gros Clark has been appointed as from Jan. 1, 1924, to the newly instituted readership in anatomy tenable at St. Bartholomew's Hospital Medical College. During 1919–20, Mr. Le Gros Clark was demonstrator in anatomy at St. Thomas's Hospital, and since 1920 has been Principal Medical Officer at Sarawak, Borneo. He has published papers entitled "Series of Ancient Eskimo Skulls," and "On the Pacchionian Bodies."

The following doctorates have been conferred: *D.Sc. in Embryology*, Miss Margaret Tribe, an internal student (University and King's Colleges) for a thesis entitled "The Development of the Hepatic Venous System and the Postcaval Vein in the Marsupialia"; *D.Sc.* (*Economics*), Mr. B. R. Ambedkar, an internal student (London School of Economics), for a thesis entitled "The Problem of the Rupee."

It was resolved that the Physiological Laboratory Library should be kept together as part of the University Library, and be developed in connexion therewith as a memorial to the late Prof. A. D. Waller.

Three free public lectures on "Some Chapters in the Recent Development of the Theory of Electrolytic Dissociation" will be given by Prof. J. N. Brönsted, of the University of Copenhagen, at University College, on December 10, 12, and 14, at 5.30 o'clock.

A course of five free public lectures on "The Influence of Environment on the Life of Bacteria" will be given by Mr. F. W. Twort, at the Royal College of Surgeons of England on December 11 13, 17, 18, and 19, at 4 o'clock.

THE use of mental alertness tests for prospective university and college students is strongly advocated by President W. D. Scott, of North-western University. All institutions of higher education should, he considers, have a "personal director" to perform "an educational function similar to that of the diagnostician in medicine. The giving of mental alertness tests will be as much a matter of the routine with such a director as is the use of the clinical thermometer by the diagnostician in medicine."

THE University College of South Wales and Monmouthshire, Cardiff, issued an appeal in December 1921 for the sum of 250,000*l.* for purposes exclusive of those connected with the development of the Medical School, and particularly with the view of the erection, equipment, and maintenance of laboratories for the Departments of Physics and Chemistry. For these purposes 50,000*l.* had been subscribed by Lord Glanely, and 10,574*l.* by other subscribers, making a total, with accrued interest (12,000*l.*), of 72,574*l.*, part of this sum having been received before the appeal in December 1921 was issued. At a luncheon given by Lord Plymouth on November 20, further gifts amounting to 56,700*l.* were announced, thus bringing the total sum realised by the appeal up to 129,274*l.* It is of interest to note that the foundations of the buildings are just being completed at a cost of approximately 15,000*l.*, and that the cost of the superstructure to accommodate these two departments, based on a recent estimate, is 144,000*l.*; this figure is, of course, exclusive of the cost of equipment and maintenance.

THE second annual report of the Education Statistics branch of the Dominion Bureau of Statistics of Canada gives the total number of university students in 1921–22, excluding preparatory, summer, and other short courses and correspondence courses, as 23,800. Included among these are: undergraduates in arts and pure science, 6859 men and 3872 women; graduates, 712 and 300; medical, 3134 and 154; engineering and applied science, 2513 and 3; music, 278 and 717; theology, 854 and 11. The teaching staffs numbered 3137, including 307 women. The total assets of the universities amounted to 67 million dollars, including endowments, 26 million, land and buildings, 27, and scientific equipment, 5 million. Incomes amounted to $9\frac{1}{2}$ million, and were derived from: investments, $1\frac{1}{2}$ million; government and municipal grants, $4\frac{1}{2}$ million; fees, 2 million; and other sources, $1\frac{1}{2}$ million.

EDUCATIONAL development and scientific research are not figuring largely in the election pledges of the several political parties and the speeches of their leaders, except those of the Labour party, and this party's promises are subject to considerable discount in view of the disproportion between the stupendous cost of carrying out its programme, including "the abolition of the slums," etc., and the resources that would be at the disposal of a Labour party government. This disproportion would necessitate the scrapping of a large part of the programme. The Liberal party manifesto contains on the subject of education only platitudes, but Mr. Asquith promised the Women's National Liberal Federation "smaller classes, provision of free places in secondary schools, State scholarships for universities, more adequate training for teachers," and "the encouragement and fuller development of adult education," while Lord Grey, when speaking on adult education on November 23, is reported to have said, "What was wanted was not State control but State assistance. For the small sum of 500,000*l.* they would get a better return than in any other way." It is part of the Conservative election policy to concentrate attention on the main issues of unemployment and protection, and the party leaders are accordingly saying little about education. Mr. Baldwin's speech of November 19 showed that he is alive to the supreme importance of the evils of juvenile unemployment, but does not suggest that he believes in retention in school as an appropriate remedy at the present time. In his speech at Reading on November 21 he referred to the importance of agricultural research and education as a permanent part of the life of the country, and remarked that the Government, recognising this, has given 1,000,000*l.* for promoting them.

Societies and Academies.

LONDON.

Royal Society, November 22.—F. **Simeon**: The carbon arc spectrum in the extreme ultra-violet—II. The spectrum of the carbon arc in vacuum extends as far in the extreme ultra-violet as that of the spark, with the exception of a very faint line at 360·5 Å, and about 25 lines have been added to the arc spectrum as already recorded. The L series of carbon can be excited by a potential of between 30 and 40 volts. A number of lines in the carbon spectrum are probably true "arc" lines. Providing the grating will give radiation in the short-wave region, the same technique suffices to photograph the spectrum from 1850 Å to 370 Å.—H. J. **Gough** and D. **Hanson**: The behaviour of metals subjected to repeated stresses. The effect of static and alternating stresses on the micro-structure of metals was examined, the main object of the research being to determine whether the crystalline structure of a metal can be affected when subjected to ranges of stress *less* than the limiting range of stress (fatigue range). With "Armco" iron, mild steel, and copper, crystalline "slip" occurs at ranges of stress considerably less than the fatigue range. It is suggested that metals can be "strain-hardened" under the action of alternating stresses, as well as under static stresses; fracture occurs, in a metal subjected to alternating stresses, when a certain limiting strain for the material is exceeded.—W. **Sucksmith** and L. F. **Bates**: On a null method of measuring the gyro-magnetic ratio. A new method is described of determining the gyro-magnetic ratio; as in the ordinary resonance method, the specimen, suspended vertically by a fine wire along the axis of a helix, is magnetised by an alternating current of the same frequency as the natural frequency of the system; but the resulting resonance amplitude is reduced to zero by a series of impulses timed to oppose those due to gyro-magnetic effect. As no measurement of magnetic moment, frequency, or damping is involved, a considerable gain in precision is obtained. The method is independent of time-lag in magnetisation, and so can be applied to Heusler alloys. The following mean values of the ratio obtained for iron, nickel and Heusler alloys were obtained: Iron 0·503; nickel 0·501; Heusler alloys 0·501.—J. H. **Shaxby**: Studies in Brownian movement.—II. The determination of Avogadro's number from observations on bacteria (cocci). A determination of Avogadro's number by measuring the displacements, due to their Brownian movements, of small spheres suspended in water was carried out with cocci. Their surfaces may be supposed to be "wetted" so that there is no slip between the water immediately adjacent and the spheres themselves, and the resistance which might arise from electrical sources depending on slip is avoided. The value of N thus found, from the large number of observations made on *Staphylococcus albus*, is $6{\cdot}08 \times 10^{23}$.—H. **Hartridge** and F. J. W. **Roughton**: The kinetics of Hæmoglobin.—II.—A. F. A. **Young**: The thermionic and photo-electric properties of the electro-positive metals.—O. F. T. **Roberts**: The theoretical scattering of smoke in a turbulent atmosphere.

Zoological Society, November 6.—Sir S. F. Harmer, vice-president, in the chair.—A. **Loveridge**: (1) East African birds (chiefly nesting-habits and endoparasites), collected 1920–1923. (2) East African snakes, collected 1918–1923. (3) East African tortoises, collected 1921–1923, with description of a new species of soft land-tortoise. (4) East African lizards, collected 1920–1923, with descriptions of two new races of *Agama lionotus* Blgr. (5) East African insects, collected 1915–1922.—I. G. S. **Montagu**: On some mammals from Jugo-Slavia.—I. G. S. **Montagu** and Miss Grace **Pickford**: The Guernsey Crocidura.—G. H. **Goldfinch**: Notes on the African crested rat (*Lophiomys imhausi*).—H. G. **Jackson**: A revision of the isopod genus Ligidium Brandt (Crustacea).—S. S. **Flower**: On additions to the snake fauna of Egypt.—S. **Hirst**: On some new or little-known species of Acari.—C. F. **Sonntag**: On the pelvic muscles and generative organs of the male chimpanzee.

Geological Society, November 7.—Prof. A. C. Seward, president, in the chair.—R. W. **Hooley**: On the skeleton of *Iguanodon atherfieldensis* sp. nov., from the Wealden shales of Atherfield (Isle of Wight). The nearly complete specimen was obtained in 1914. There is an essential similarity as regards the relationship of the bones of the skull to the American pre-dentate dinosaurs. Grooves on the premaxillæ prove that the tip of the snout was sheathed in horn. The quadrate bone articulated freely with the squamosal, and there was a fore-and-aft action of the mandible. The tongue must have been extremely narrow, with a broad tip, and prehensile. The neck was habitually flexed, the point of greatest arching being at the ninth cervical. All the pre-sacral vertebræ carry ribs. The sacrum comprises six fused vertebræ. The ossified elements of the left carpus were preserved. The integument was very thin and covered with small tubercles, interspersed with groups of large polygonal plates, as in Trachodon. The estimated length of the skeleton is 6·3 m. (about 21·6 feet). *I. atherfieldensis* is distinct from any known species, and the skull and bones are intermediate in form between that of *I. mantelli* and *I. bernissartensis*.—S. H. **Reynolds**: The igneous rocks of the Tortworth inlier. The igneous rocks occur in two bands, the upper of which is associated with calcareous tuffs containing Silurian fossils and is doubtless lava. The lower band appears to be intrusive. The rocks of the two bands have several features in common. The rocks of the lower band are characterised by the presence of pseudomorphs after olivine, and may be grouped as olivine-enstatite-basalts. Those of the upper band are devoid of olivine, and consist of pyroxene-andesite. They are characterised by the presence of highly corroded xenocrysts of quartz and felspar, and by the occurrence of variolitic and glassy patches in the ground-mass.

Linnean Society, November 15.—Dr. A. B. Rendle, president, in the chair.—E. J. **Salisbury**: The relation of earthworms to soil reaction. Natural undisturbed soils usually show a definite gradient with respect to organic material and acidity, both of which tend to attain a maximum at the surface. Analyses of worm casts show that these have a high organic content indicating their origin from the superficial and most acid layers. Comparison of the hydrogen ion concentration of worm casts and surface soil shows that acid soils tend to be rendered much less acid by passage through the worm. Markedly alkaline soils may similarly be rendered less alkaline. The former action may be attributed to the calciferous glands. The greatest frequency of worms is met with in soils with approximately neutral reaction.—Miss E. M. **Blackwell**: The flora of Solomon's Pools. Solomon's Pools lie about six miles south of Jerusalem, 2616 feet above sea level, in a valley, Wâdy Artâs, which runs east and west between low hills of red-brown ferruginous earth through which limestone bosses project. The pools, three in number, are obviously artificial. The middle and lowest pools have been

cleaned and partly repaired, and pumping plants erected. In July 1923 the uppermost pool had already dried up. The clear water of the pools supported a luxuriant growth of *Chara connivens* in the lowest and *C. contraria* and *C. fragilis* in the middle pool, forming almost a pure society. In the middle pool there was in addition an aquatic grass and a new filamentous algæ, desmids and diatoms. In the lowest, *Potamogeton flabellatus* var. *scoparius* was flowering and fruiting, almost rivalling the Chara for dominance. At the deeper end of the lower pool were tufts of *Riella helicophylla*, their spirally coiled thalli floating out into the water in loose rosettes at a considerable depth. Where the floor of the west side of the lowest pool was exposed on account of the slope, the drying mud was covered with bleached plants of Chara, and growing up through it *Typha latifolia*, *Scirpus maritimus*, *Heleocharis palustris*, and *Euphorbia aleppica*. The flora is similar to that of the "slacks" in the Lancashire sand-dunes. The waters in both cases have a high percentage of dissolved solids, especially chlorides and carbonates.—R. E. **Chapman**: The carbohydrate enzymes of certain Monocotyledons. The material used was the green foliage leaves of the snowdrop, the onion, and the leek, with a starch-forming plant, a common dock, for purposes of comparison. The leaves were air-dried, powdered, and added to dilute solutions of starch, dextrine, maltose, cane sugar, and amygdalin, using qualitative tests and changes in the rotation of polarised light for the detection of hydrolysis. Toluol was used as antiseptic and the solutions incubated at 39° C. The results indicated that of the five carbohydrate enzymes—amylase, dextrinase, maltase, invertase, and emulsin—maltase and emulsin were absent from the snowdrop, dextrinase from the onion, amylase from the leek, but all five were present in the dock. The formation of starch in the parenchyma cells of the three Monocotyledons is thus prevented, because the necessary set of enzymes is incomplete. In certain cases (*e.g.* Galanthus and Narcissus) starch is always present in the guard cells, and prolonged starvation in darkness does not cause the disappearance of this starch. In the snowdrop the adult leaf has starch in the guard cells together probably with diastase but not maltase, so that hydrolysis can proceed only to maltose, and the system, starch $\rightleftarrows$ maltose catalysed by diastase, may be part of the mechanism controlling the opening or closing of the stomata.

Royal Meteorological Society, November 21.—Dr. C. Chree, president, in the chair.—L. F. **Richardson**: Attempts to measure air temperature by shooting spheres upward. Whilst making observations of the upper wind by shooting polished steel spheres upwards in a direction slightly inclined from the vertical so that the wind caused the returning sphere to fall quite close to the gun, the time of absence of the sphere can afford a measure of a mean temperature of the air through which it has passed. The upper air temperature was measured from the mean of six shots with a standard error of 1° C. at sunrise in calms or light winds. On such occasions, there is often a layer of cold stagnant air near the ground, so that the temperature in the Stevenson screen is a poor guide to the temperature at 70 metres. Here the projectile may be useful.—S. N. **Sen**: On the distribution of air density over the globe. Thirteen charts of "isopycnics" or lines of equal air density are drawn depicting the density distribution at the various levels. The air density at the 8 km. level all over the globe is illustrated by the chart for that level. The air density is controlled by temperature up to a height of about 8 km. and by pressure above that level. The name "thermosphere" is proposed to denote the atmospheric shell in which temperature is the controlling factor, and "barosphere" that in which pressure is the controlling factor. On the average, when the temperature is rising in one hemisphere there is a diminution of air density in the thermosphere and an increase in the barosphere, and the effect of diminishing temperature in the other hemisphere is the reverse. These opposite thermometric tendencies create a mechanism for the automatic breaking down of the stratification of the free atmosphere. This mechanism, or the "convective cycle" which is postulated to be established between the North and South poles, also affords a means for the interchange of air between the two hemispheres.

PARIS.

Academy of Sciences, November 5.—M. Albin Haller in the chair.—The president announced the death of M. Arnaud de Gramont, member of the section of free Academicians.—G. **Ferrie**, R. **Jouaust**, and R. **Mesny**: The amplification of the current from photo-electric cells and its applications. The currents produced by photo-electric cells are very small, of the order of 10^{-10} amperes. These can be magnified by the use of a three-electrode lamp as a relay without inertia. A magnification of 1000 has been obtained with a lamp of the dimensions of an ordinary receiving lamp; with an emission lamp of 50 watts working under 1000 volts, an amplification of 10,000 was obtained. A more complicated method, based on the conversion of the photo-electric current into an alternating current and transforming up, is described: this permits of amplifications up to the order of 10^6.—J. **Costantin**: The Pleurotus of the blue thistle of the Vanoise.—L. **Maquenne**: The theory of chlorophyll synthesis. A discussion of the Boussingault-Bæyer theory of chlorophyll synthesis of the carbohydrates. An alternative hypothesis is put forward in which quadrivalent magnesium is assumed. Carbonic acid is assumed to be taken up by direct addition to the : N – Mg – N : groups; the assumption of the intermediate formation of formaldehyde is unnecessary.—Andre **Bloch**: Paratactic congruences and Dupin's cyclid.—M. **Angelesco**: The generating functions of Hermite polynomials.—Emile **Borel**: Remarks on the preceding communication.—J. **Wolff**: Non-measurable ensembles.—N. **Gunther**: A problem of hydrodynamics.—A. **Foch**: The dynamicable similitude of an aspiration tube and its model. A discussion of the application of aspiration tubes to turbines, with especial consideration to the formulæ governing the relations between models and the full-size turbine.—Louis **Breguet**: The calculation of the weight of combustible consumed by an aeroplane during ascent. The formulæ for the effective range of an aeroplane have been worked out on the assumption of horizontal flight. Modifications are introduced into the Rateau equation showing the variations in petrol consumption during ascent and descent.—C. **Chéneveau** and J. **Callame**: A micropalmer. A description, with diagram, of an instrument designed for measuring the thickness of thin sheets or plates of rubber or other plastic material, with an accuracy of 0·001 mm.—E. **Brylinski**. Michelson's experiment.—Mlle. Berthe **Perrette**: An arrangement of the electric arc in a vacuum allowing the spectra of metals to be obtained with very small quantities of material. The cathode is formed of tungsten (or tungsten-thorium) wire, and the anode of a tungsten plate in which a small cavity is drilled to hold the material. The cathode is raised to a high temperature by a current of 4 to 5 amperes from accumulators.

The voltage between anode and cathode is 110 volts, the whole working in a vacuum of about 0·002 mm. of mercury. The lines of the spectrum given by this apparatus are very fine and give high orders of interference, and less than 0·05 gm. of material can be taken.—N. **Perrokis**: Study on the stability, in the presence of water, of a certain number of binary mixtures. Two groups of pairs of miscible liquids were studied: ethyl alcohol with phenyl ether, benzene, *o*-cresol, phenol; benzene, with various alcohols. The figure determined was the quantity of water necessary to produce two layers when added to 100 gm. of the binary mixture. Some results are given in a diagram.—N. D. **Zelinsky**: The polymerisation of acetylene by contact.—B. Darder **Pericás**: The tectonic of the neighbourhood of Sineu and of Ping de Sant Onafre (Island of Majorca).—Jules **Wolff**: The conditions favourable or prejudicial to the germination of the seeds of orchids and to the development of the seedlings. The seeds of the orchid can be germinated aseptically in a rich medium, and in the absence of fungi. The seedling can then be planted out on mycelium, and symbiosis is established normally. The presence of the fungus at the commencement of the germination is not only unnecessary, but may prove injurious to the seedlings.—J. **Dauvergne** and Mlle. **Weil**: The culture of plants in a sterile liquid medium. A development of Mazé method, the seeds being supported on perforated aluminium plates.—C. **Fromageot**: Assimilation in the green cells and the structure of the protoplasm.—Lucien **Daniel** and Jean **Ripert**: Researches on the variations of chemical action in grafted plants.—A. **Maige**: The metabolism of the sugars in the cell and amylogenesis. It results from the experiments described that even in cells where amylogenesis requires only a very low concentration in sugar, the essential phenomena of cellular metabolism which assure the continuity of life and growth of the living material may be effected at still lower concentrations.—**Chavastelon** and J. **Luquet**: Contribution to the study of the edaphic conditions of the pastoral associations in the massif of Mont-Dore.—Emile F. **Terroine**, R. **Bonnet**, and P. H. **Joëssel**: The composition of seeds and yield of energy in germination.—Mme. L. **Randoin** and H. **Simonnet**: The influence of the nature and quantity of the glucides present in a ration deprived of factor B on the precocity of appearance of the accidents of polyneuritis in birds. In constructing an artificial diet for experiments on diet deficiency, it is very important to take into account the digestive utilisation of each of the food materials composing the diet. The experiments give some support to the idea that the magnitude of the factor B requirement is not absolute but is relative and in direct relation with the degree of utilisation of one or several elements of a ration, and, in particular, with the quantity of sugars assimilated.—Paul **Voukassovitch**: The biology of two parasitic Hymenoptera of Pyralis of the vine.—Marc **Bridel** and Jean **Charpentier**: The biochemical characterisation of galactose in a mixture containing galactose and arabinose. Galactose can be detected in the presence of arabinose, by the action of emulsin in 70 per cent. alcoholic solution. The β-ethylgalactoside can be obtained in the crystalline state, suitable for identification.—André **Lwoff**: A new free ciliated Infusorian, *Stephanopogon Mesnili*. Its taxonomic importance.—Mlle. M. **Gauthier**: The development of the egg and embryo of Cyathocephalus, a parasite of the trout.—Henri **Stassano**: The double rôle of the heating plates in apparatus for the sterilisation of liquids in continuous circulation.

Washington, D.C.

National Academy of Sciences (Proc., Vol. 9, No. 10, October).—L. B. **Loeb**: The mobilities of electrons in air. The mobilities of electrons in air at pressures of 41, 51·5, 60, 66·5, and 92 mm. of mercury were measured in an ion chamber. A constant field superposed on the actuating alternating field was used to neutralise the field produced by the accumulation of ions. Plotting mobility constant (mobility reduced to atmospheric pressure) against critical voltage (static voltmeter) minus retarding potential, curves are obtained showing breaks probably due to attachment of electrons to molecules. Expressions are given for the mobility constants for the distance separating the plates in the ion chamber (1·955 cm.).—P. W. **Bridgman**: The thermal conductivity of liquids. A radial flow apparatus with the liquid between two concentric metal cylinders was used. The inner cylinder was the source of heat, and conductivities were measured at 30° C. and 75° C., and at atmospheric pressure, 6000 kg./cm.^{2} and 12,000 kg./cm.^{2} pressures. Water and fourteen organic liquids were used. Conductivity decreases with rise of temperature, at atmospheric pressure, except for water. At constant temperature, it rises with increasing pressure; at 12,000 kg./cm.^{2}, the increase is from 1·5 to 2·7 fold, the more compressible liquids showing the greater increase. The absolute conductivities at 30° C. range from 0·000505 (methyl alcohol) to 0·000265 (ethyl iodide); for water the value given is 0·00144. A formula connecting the conductivity, gas constant, velocity of sound in the liquid, and the mean distance of separation of the centres of the molecules of the liquid, is derived. The high value for water is referred to its low compressibility and the closeness of the centres of its molecules.—E. S. **King**: (1) Photovisual magnitudes of one hundred bright stars. The Draper 8-inch refractor was used and Cramer Isochromatic Instantaneous plates with a yellow filter. All the plates were taken 1·25 cm. or more outside the focus. Results for A0 stars agree with the photometric magnitudes. In general, the photovisual colour index is greater than the visual or photometric index. (2) Revised magnitudes and colour indices of the planets (*v.* Nature, November 24, p. 769).—R. H. **Bowen**: The origin of secretory granules. Nassonov, working on Salamander glands, showed that early secretory granules are associated with the Golgi apparatus of cells and afterwards have caps or girdles of Golgi material. These results are confirmed. It is suggested that the acrosome of the animal sperm, which arises as a vesicle in close connexion with the Golgi apparatus, and from which the Golgi apparatus is finally separated, is a secretory granule applied to the head of the mature sperm, whence its substance may be released at fertilisation. Referred to other gland cells, the hypothesis suggests that there is direct relation between the Golgi cells and chemical synthesis, and in particular enzyme formation.—R. R. **Huestis**: The heredity of microscopic hair characters in Peromyscus. Two geographic races (coast- and desert-race) of two species of deer-mouse were used. Each coast-race differed from the corresponding desert-race in much the same way. It is concluded that the differences observed between contrasted races have been evolved in the wild state, and some at least are the effect of environment. The results indicate Mendelian inheritance of multiple factors.—C. G. **Abbot**: Preliminary note on the variation of the sun's visible features associated with variations of solar radiation (*v.* Nature, November 17, p. 738).

Official Publications Received.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 475: Visibility of Radiant Energy. By K. S. Gibson and E. P. T. Tyndall. Pp. 131-191. 15 cents. Technologic Papers of the Bureau of Standards, No. 242: Detector for Water Vapor in Closed Pipes. By E. R. Weaver and P. G. Ledig. Pp. 637-644. 5 cents. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 45: Work of the Bureau of Education for the Natives of Alaska. By William Hamilton. Pp. 4. (Washington: Government Printing Office.) 5 cents.

U.S. Department of Agriculture. Farmers' Bulletin No. 1354: The Yellow-Fever Mosquito. By L. O. Howard. Pp. 14. (Washington: Government Printing Office.) 5 cents.

Department of the Interior: United States Geological Survey. Mineral Resources of the United States in 1922 (Preliminary Summary). Introduction by G. F. Laughlin; Statistics assembled by Martha B. Clark. Pp. iv+124A. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 689: Boundaries, Areas, Geographic Centers and Altitudes of the United States and the Several States; with a Brief Record of Important Changes in their Territory. By Edward M. Douglas. Pp. vi+234+7 plates. 60 cents. Bulletin 709: Triangulation and Primary Traverse, 1916-1918. Pp. vi+914+2 plates. 75 cents. Bulletin 739: Mineral Resources of Alaska: Report on Progress of Investigations in 1921. By A. H. Brooks and others. Pp. vi+169+xiv+3 plates. Professional Paper 132-A: Rock Formations in the Colorado Plateau of South-eastern Utah and Northern Arizona. By C. R. Longwell, H. D. Miser, R. C. Moore, Kirk Bryan, and Sidney Paige. Pp. 23+10 plates. (Washington: Government Printing Office.)

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1923. Edited by Prof. Alexander Meek. Pp. 151+21 plates. (Cullercoats.) 5s.

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Twenty-seventh Session, adopted at the Annual Meeting of Governors held on the 16th October 1923. Pp. 70. (Glasgow.)

Annalen van de Sterrewacht te Leiden. Deel 13, Stuk 3: Positions of 84 Stars near the North Pole determined with the Meridian Circle of the Observatory in the Years 1877-1885, under the Directorate of Prof. Dr. H. G. van de Sande Bakhuyzen. Pp. 63. Deel 14, Stuk 2: Dessins de la voie lactée faites à Athènes par J. Fr. Julius Schmidt dans les années 1864-1876. Pp. 8+4 plates. (Haarlem: Joh. Enschede en Zonen.)

Marconi's Wireless Telegraph Company, Ltd. Report of the Directors and Statement of Accounts for the Year ended 31st December, 1922, to be presented at the Annual General Meeting of the Company, to be held at the Connaught Rooms, Great Queen Street, Kingsway, London, W.C.2, on Monday, the 3rd December, 1923, at 12 o'clock noon. Pp. 12. (London: Marconi House, Strand.)

Diary of Societies.

SATURDAY, DECEMBER 1.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 8.—F. R. S. Balfour: Trees and Flowers of the North-West Pacific Coast.

MONDAY, DECEMBER 3.

ROYAL INSTITUTION, at 5.—General Meeting.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—J. W. Gordon: Railway Surveying by Photography.

ROYAL SOCIETY OF MEDICINE, at 5.30.—Dr. Strandberg: Treatment of Tuberculosis of the Nose and Throat by Finsen Light Baths: Results.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—C. M. R. Balbi and others: Discussion on Electrical Apparatus for the Deaf.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. Dorothy Wrinch-Nicholson: Some Aspects of Scientific Method.

ROYAL SOCIETY OF ARTS, at 8.—Prof. A. F. Barker: Recent Progress in the Wool Industries (Cantor Lecture) (1).

INSTITUTION OF THE RUBBER INDUSTRY (London Section) (at Engineers' Club, Coventry Street), at 8.—Major V. Lefebure: Accelerators.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—J. Allen Howe: The Use and Preservation of Building Stone.—J. J. Fox and T. W. Harrison: The Chemical Aspects of Building-Stone Decay.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Sir Charles Bell: A Year in Lhasa.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 8.30.—Sir Leonard Rogers and others: Discussion on Sprue and Cœliac Disease.

TUESDAY, DECEMBER 4.

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—J. H. Anderson: Spontaneous Ignition of Coal.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Dennis Taylor: The Future of the Cinema; and Photography as an Extension of Vision. (Annual Traill-Taylor Memorial Lecture.)

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—H. Balfour: Observations on the Technology of the Nagas of Eastern Assam.

RÖNTGEN SOCIETY (at British Institute of Radiology, 32 Welbeck Street), at 8.15.—Dr. L. G. Heilbron: Modern Radiographical Technique.

WEDNESDAY, DECEMBER 5.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—D. J. Farquharson: The Geology of Southern Guernsey.—C. W. Osman: The Geology of the Northern Border of Dartmoor, between Whiddon Down and Butterdon Down.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Pathological and Clinical Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—L. B. Turner: The Relation between Damping and Speed in Wireless Reception.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS, INC. (at Engineers' Club), at 7.—A. J. Assheton: Vacuum Steam Heating.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—H. Toms: Crystalline Bromides of Linseed Oil.—M. S. Salamon: The Plea for Standardisation.—H. T. S. Britton: Note on the Estimation of Chromium.—R. L. Andrew: The Colorimetric Estimation of Lead in Cream of Tartar.

ROYAL SOCIETY OF ARTS, at 8.—Dr. A. W. Hill: The Work of the Royal Botanic Gardens, Kew.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, DECEMBER 6.

ROYAL SOCIETY, at 4.30.—E. G. T. Liddell and Sir Charles Sherrington: Recruitment Type of Reflexes.—G. S. Carter: The Structure and Movements of the Latero-Frontal Cilia of the Gills of Mytilus.—*To be read in title only*:—V. B. Wigglesworth and C. E. Woodrow: The Relation between the Phosphate in Blood and Urine.—J. B. S. Haldane, V. B. Wigglesworth, and C. E. Woodrow: (*a*) The Effect of Reaction Changes on Human Inorganic Metabolism; (*b*) The Effect of Reaction Changes on Human Carbohydrate and Oxygen Metabolism.—J. A. Campbell: Concerning the Influence of Atmospheric Conditions upon the Pulse Rate and "Oxygen-Debt" after Running.—J. Gray: The Mechanism of Ciliary Movement. IV. The Relation of Ciliary Activity to Oxygen Consumption.

ROYAL SOCIETY OF MEDICINE, at 5.30.—Sir Jagadis C. Bose: Assimilation and Circulation in Plants.

NEWCOMEN SOCIETY (Annual General Meeting) (in Room 13, Caxton Hall), at 5.30.—I. B. Hart: The Dynamics of Leonardo da Vinci.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—L. Brooks: The Beginnings of Geographical Teaching.

CHEMICAL SOCIETY, at 8.—C. K. Ingold: The Additive Formation of Four-membered rings. Part III. A System of Nomenclature for Heterocyclic Four-membered Rings and the Formation and Properties of some Derivatives of β-Methylenedi-imineoxide.—H. J. S. Sand and E. J. Weeks: The Dependence of Polarisation-Overvoltage on Hydroxyl and Hydrogen Ion Concentration. Part I. Polarisation-Overvoltage of an Antimony Cathode in Aqueous Alkaline Solution.—H. King: Stereoisomerism and Local Anæsthetic Action in the β-Eucaine Group. Resolution of β- and Iso-β-Eucaine.—A. Green: β-Alizarin. An Isomeric Form of Alizarin.—O. L. Brady and F. P. Dunn: The Isomerism of the Oximes. Part XV. The Supposed Fourth Benzildioxime.—W. E. Garner and F. C. Randall: The Alternation in the Heats of Crystallisation of the Normal Monobasic Fatty Acids.

FRIDAY, DECEMBER 7.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—W. Foster: The Archives of the Honourable East India Company (Sir George Birdwood Memorial Lecture).

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion: Gravity Deflections in Great Britain and the Geoid. Chairman, Col. E. M. Jack. Opener, Sir C. F. Close. Other speakers, H. L. P. Jolly, A. R. Hinks, Col. H. L. Crosthwait, Dr. J. W. Evans, and Capt. G. T. McCaw.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Life and Times of William Clift, First Conservator (Thomas Vicary Lecture).

PHILOLOGICAL SOCIETY (at University College), at 8.—C. R. Enock: Euphratean Origin of Man, Language, and Place-Names.

ROYAL SOCIETY OF MEDICINE (Surgery, Ophthalmology, Otology, Laryngology, Odontology, and Anæsthetics Sections), at 8.30.—Dr. P. Watson-Williams and others: Discussion on The Comparative Value of Cocaine Substitutes.

PUBLIC LECTURES.

SATURDAY, DECEMBER 1.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Natural History of Dragons.

BIRKBECK COLLEGE, at 6.—Dr. F. H. Hayward: Celebration of The Geologist.

MONDAY, DECEMBER 3.

LONDON HOSPITAL MEDICAL COLLEGE, at 4.15.—Dr. Gordon Holmes: Some Symptoms of Cerebral Irritation (Schorstein Memorial Lecture).

TUESDAY, DECEMBER 4.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Roots of Early Greek Philosophy: (2) Scientific.

WEDNESDAY, DECEMBER 5.

UNIVERSITY COLLEGE, at 5.30.—W. C. B. Sayers: Library Classification in Modern Life.

THURSDAY, DECEMBER 6.

KING'S COLLEGE, at 5.30.—Dr. A. R. Pastor: Spain and Europe (League of Nations Union Lecture).

FRIDAY, DECEMBER 7.

UNIVERSITY COLLEGE, at 5.15.—Prof. Karl Pearson: Eugenics.

SATURDAY, DECEMBER 8.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. M. Delf: Sunlight and Life.

SATURDAY, DECEMBER 8, 1923.

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Research Professorships.

THIS year's anniversary meeting of the Royal Society, an account of which is given elsewhere in the present issue of NATURE, was the first since Sir Alfred Yarrow made his munificent gift of 100,000*l.* to the Society in February last, "to mark my sense of the value of research to the community." The meeting was, therefore, appropriately devoted in the main to an account by the president, Sir Charles Sherrington, of the purposes to which this and other large benefactions are to be used. The essential aim of the Society is the creation of new knowledge by scientific inquiry, and the new professorships which have been founded through recent gifts will promote and facilitate this intention.

Lord Justice Warrington, in proposing the toast of the Royal Society at the anniversary dinner at the Hotel Victoria, drew a parallel between the proceedings in a court of law and those in a laboratory of science. In both cases evidence is elicited with the object of arriving at a correct judgment upon it, and endeavours are made by cross-examination to test the truth of the testimony given. The suggestion that it is much easier to get truthful response by appropriate stimulus in Nature than it is from human witnesses is, however, one to which scientific investigators may hesitate to subscribe. Nature can never be trusted to give a direct answer to a question if she can avoid it, and will deceive the inquirer if she can. Also, while the laws of civil life can be broken, there must be no exception to a law of Nature, which is simply a description of certain relationships expressed in words or in mathematical terms. When observations prove such a relationship to be incorrect, then the law has to be modified or abandoned to take the new facts into consideration. Moreover, while in civil law precedent is all-powerful, in science it counts, or should count, for nothing.

The motto of the Royal Society, *Nullius in verba*, adapted from Horace's *Nullius addictus iurare in verba magistra*—not bound to swear to the words of any master—is an expression of the revolt against authority which was in the ascendant when the Society was founded. Long before the reaction against the Aristotelian method and doctrine which Francis Bacon represented with such virulence and bitterness, Roger Bacon had claimed for himself and his contemporaries the liberty of independent inquiry. At the Renaissance, impatience with the constant appeal to the authority of Aristotle was widespread among all who were foremost in the revival either of science or of letters, and what Francis Bacon did in his "Novum Organum"

was to embody prevailing views and propound a new philosophy.

In his "New Atlantis," Bacon planned a palace of invention, a great temple of science, where the pursuit of natural knowledge in all its branches was to be organised on principles of the highest efficiency. His Solomon's House was regarded as a prophetic scheme of the Royal Society, and the story of it as a vision of the practical results to be anticipated from diligent and systematic study of Nature. By the establishment of research professorships the Society is directly creating a body of experimenters on this design, which was that originally conceived for it, in addition to being "the Store-House of Natural Philosophy."

When a research professor is already associated with a university or other teaching institution, the appointment will mean that the professor will be relieved of his lectures and other duties of instruction of students. The amount of time which this work and participation in administrative affairs demand differs in different centres, but in most cases it leaves little opportunity for sustained attention to research problems. Prof. Alfred Fowler, who has been appointed to one of the Yarrow research fellowships, is professor of astrophysics at the Imperial College of Science and Technology, London; and though he has not perhaps been so overwhelmed with instructional responsibilities as are many professors in provincial universities, yet much of his time has had to be given to them, and the time left for his experimental investigations has been correspondingly limited.

Prof. Fowler's main contributions to astronomical physics are described in Sir Charles Sherrington's presidential address. The modern phase of his work may be said to have begun in the year 1912, when he succeeded in obtaining, from a tube containing helium and hydrogen, certain series of lines, some of which had previously been observed only in the spectra of a few stars or had been predicted on theoretical grounds as forming part of the spectrum of hydrogen. Shortly afterwards, Bohr published his now famous theory of the origin of spectra, in the light of which the series detected by Fowler were seen to be due to helium, and with this discovery began the close association between the experimental work of Fowler and the theoretical work of Bohr which has led to such remarkable advances in recent years.

In the Bakerian Lecture of 1914, Fowler showed that the enhanced lines of the alkaline earth metals formed series precisely similar to those of the "arc" lines, except that the series constant had four times its normal value. According to Bohr's theory, this meant that the enhanced lines were produced by atoms which had lost one electron, and the generalisation at once followed that the atoms of any element which had lost one electron would yield series having 4N in place of the Rydberg constant, N. Carrying the process still further, Fowler has recently shown that the spectrum of silicon contains series characterised by a constant 16N, indicating the existence of radiating atoms which have lost three electrons.

A great deal of Prof. Fowler's time has been devoted to the training of research students, whose work testifies to the encouragement and help they have received from him. Curtis's determination of the Rydberg constant for hydrogen, and Catalan's remarkable paper on the spectrum of manganese, may be mentioned as two of many examples of work of this kind. It is a matter for regret that his new appointment entails the cessation of the very clear and interesting courses of lectures from which students of the Royal College of Science have benefited for more than twenty years, but there is no doubt that the gain to science resulting from his larger opportunities for research work will be immense.

Major Taylor has not occupied a professorial chair, but he is lecturer in mathematics at Trinity College, Cambridge, and will continue his work there as Prof. Fowler will at the Royal College of Science. The new professors may take part in instruction, or not, but no work of this kind is to be undertaken if it should prevent them from giving the best of their energies to research. The holders of the Yarrow research professorships are to devote their whole time to research in mathematical, physical, chemical, or engineering science. The professorships are similar to the Foulerton medical research professorship of 1400*l.* or more per annum, and may be compared with the Foulerton medical research studentship of 700*l.* per annum, the Sorby research fellowship of 600*l.* per annum, and the Beit memorial senior medical research fellowships of 600*l.* per annum. Particulars of these are given in the Yearbook of the Universities of the Empire (Appendix XXIV.). It may be of interest in connexion with these endowments to mention that there are a few similar foundations in the United States, notably the Heckscher Research Foundation, established in 1920 in Cornell University. "As research in America," said the founder, "suffers from the exhaustion of professors by teaching and other duties, it is my desire that professors and instructors . . . shall . . . for such periods of time as the university authorities may prescribe, be liberated partially or wholly from those duties," etc.; for the present the income is not to be used for permanent research professorships. Senator Vilas likewise bequeathed to the University of Wisconsin money for creating ten chairs of pure research without routine work, in which the salaries (10,000 dollars) would attract

men of worth. The experiences of Johns Hopkins and Clark Universities, both of which were intended to be institutions for original scientific research, have shown the great difficulties that stand in the way of establishing independently of the state a university which shall be exclusively a school of advanced studies.

In Canada, Queen's University of Kingston, Ontario, has a Chown science research chair (in physics or chemistry), which was recently vacated by Dr. A. L. Hughes on his acceptance of a chair of physics in the University of Washington, St. Louis; and in connexion with the University of Alberta two "research professors" have been employed under the direction of an Industrial Research Council, of which the Premier of the Province was chairman, their fields of investigation being fuels and road materials. In Australia, the University of Queensland has lately established a research professorship of medical psychology.

In deciding that for the present the income is not to be used for *permanent* research professorships, the Heckscher trustees may have been influenced by criticisms which have been directed against the Carnegie Institution of Washington on account of their heavy budget for permanent establishments, which seems not altogether consistent with the original idea of the founder—to discover exceptionally endowed men in various specialities and give them for the time being the broadest facilities for accomplishing more or less definite pieces of work. It is their immunity from the risk of becoming overweighted with fixed establishment charges that contributes so largely to the success of foundations like the Mellon Institute, where research is organised on a "job" or contract system, the problem being set by a person or firm interested in its solution, the scientific worker being found and engaged, *ad hoc*, by the Institute, and a "fellowship" being assigned for a definite period fixed with reference to the probable duration of the research; in many cases the fellow is promised a "bonus" (which has in some cases reached 10,000 dollars) or a percentage on the industrial exploitation of the process studied.

All these research foundations differ, however, from those now established by the Royal Society inasmuch as they are associated with particular institutions. In the Society's scheme, there is perfect freedom as to the place of research, and the main intention is to give an investigator of proved worth the means to continue his explorations of the field of Nature undisturbed by other duties, and with his eye always towards the light. We welcome the generous recognition thus given to research as a profession, and believe that the action described by Sir Charles Sherrington marks the beginning of an important epoch in the history of the Royal Society.

Electronic Theories for Chemists.

(1) *The Electron in Chemistry: being Five Lectures delivered at the Franklin Institute, Philadelphia.* By Sir J. J. Thomson. Pp. v+144. (Philadelphia: The Franklin Institute, 1923.) 1.75 dollars.

(2) *Valence, and the Structure of Atoms and Molecules.* By Prof. G. N. Lewis. (American Chemical Society Monograph Series.) Pp. 172. (New York: The Chemical Catalog Co., Inc., 1923.) 3 dollars.

(1) SIR JOSEPH THOMSON'S book contains the substance of five lectures which were delivered so recently as April of the present year. The reviewer believes that it was dedicated to chemists and has read it in that light, for in no other can he pretend to see.

As is well known, the author does not subscribe to all the newer physical doctrines and is hopeful of founding a theory of the atom with the aid of less revolutionary postulates. Starting from the conception of the atom as a massive, positively electrified centre surrounded by electrons, Sir Joseph Thomson begins by admitting that the properties of the atom require the introduction of some principle not recognised in the older physics. This principle he supposes to affect the law of force between the nucleus of the atom and the electrons in such a way that at a certain distance the force changes from attraction to repulsion. The introduction of a new term into the expression of the usual inverse square law gives the required result, albeit somewhat indifferently well, and the corresponding stability of various electrically neutral systems composed of electrons, apparently stationary, can be worked out. The now familiar octet emerges naturally enough from such considerations, but the origin of the pair of electrons which form the "shell" of the helium atom and the K layer of heavier elements is left obscure, nor is it at once evident why the octets of the inert gases are relatively so extremely stable.

If no more than an adumbration of the periodic system is to be seen in the somewhat tentative theory which the author here proposes, this fact should not be allowed to weigh too heavily against it, lest hereafter it may prove that other theories have sacrificed too much in order to retain a predetermined outward form.

In chapter ii. the combination of atoms by means of one, two, or more electrons is considered, and it is explained why lithium, beryllium, boron, and carbon are solids whilst oxygen, fluorine, and neon are gases, and why, for example, the study of the mode of scattering of polarised light by gases furnishes evidence that the molecule of oxygen is more elongated than that of, say, hydrogen. Careful readers, however, will note that nitrogen does not fit into the picture, and will

suspect that Sir Joseph Thomson has abandoned an earlier intention of assigning to the molecule of this element a configuration not unlike that of the atom of an inert gas.

The method of positive ray analysis, which originally we owe to the author's genius, has given many results which scarcely admit of misinterpretation, a virtue not always conspicuous in the conclusions derived from other methods of investigation of atoms and molecules. Chemists will therefore turn eagerly to those pages in which Sir Joseph Thomson explains how positive rays throw light upon the chemical properties of the elements.

Highly interesting and suggestive, too, are those sections of the work which treat of polar molecules and their importance in connexion with chemical reactivity, as, for example, the explosiveness of certain gas mixtures and the inertness of certain carefully dried systems such as those included in the classical experiments of H. B. Dixon and of H. B. Baker. These ideas on polarity are extended to explain electrolytic dissociation in solutions, the formation of the double layer, and the principle of the Armstrong hydroelectric machine, to mention only a few applications.

The conditions which give rise to the development of electrical polarity in a molecule are treated from an elementary point of view, and the principles are used to explain the varying acidness of hydroxylic compounds and substitution in hydrocarbons and their halogen derivatives.

Residual affinity, active molecules, Werner's co-ordination numbers, production of light during chemical change, magnetic characters of elements and compounds, and of oxygen in particular, are also considered. Nor does Sir Joseph Thomson omit discussion of Thiele's theory of conjugation and related questions; but the applications of his views to organic chemistry have undergone some modification since the book was written, as comparison with his recent contribution to the *Philosophical Magazine* will show.

The electronic theory of solids occupies the last chapter of the work, and as this involves the treatment of crystal structure, compressibilities of metals and other elements, surface tension, intermetallic compounds and mixed crystals, it will make a special appeal to chemists and metallurgists who can think in three dimensions, and there is much of interest for others.

The text is freely interspersed with mathematical symbols, but there is little that cannot be comprehended by those who have a knowledge of algebra and elementary physics. Chemists owe to Sir Joseph Thomson grateful thanks for a work which illuminates many of the dark corners of their science with the glow of his rich knowledge and experience.

(2) The current of orthodox opinion on electronic theories of valency has changed its course so often that the permanence of any one aspect of the subject cannot be assumed. Nevertheless, the adjective "ephemeral," which Prof. Lewis suggests in reference to his monograph as a whole, should properly be applied only to the latter half of the work. The earlier chapters, which deal with the pageant of discoveries and ideas which led up to the present position of our knowledge of the atom, could scarcely be bettered as an initiation to the subject, and are distinguished by an ingenious arrangement of the material and by the graphic way in which it is described.

Beginning with Dalton's conceptions of the discontinuity of matter, the author leads, by several converging paths in turn, to the ionic dissociation theory, to the discovery by J. J. Thomson of the electron, and to the electronic conception of the atom. The ideas of Abegg, Thomson, Kossel, and others in relation to the octet theory are explained, while an interesting reproduction of some of his own lecture notes of 1902 throws light on the embryology of the cubic atom.

Later in the book, Ramsay is credited with the first idea of electrons shared by two atoms (1908). Stark's conception of valency electrons attracting simultaneously the positive parts of two different atoms is given great prominence and illustrated with four diagrams. Parson and Kossel are not forgotten in this connexion, and the author generously makes out the best case for every possible claimant to a share in the development of the notion of co-valency.

The history of the Bohr atom is also expounded in the introductory chapters, and thus spectral series, radiant heat, specific heats at low temperatures, Planck's oscillators, the quantum theory, and Einstein's photoelectric equation come forward in turn for exposition, the significance of each being made clear. Bohr's theory of the hydrogen atom and some of its more striking applications to the theory of emission and X-ray spectra, ionisation and resonance potentials, are explained in a simple way.

Werner's theory of co-ordinated compounds, or at least that part of it now accepted as a permanently useful generalisation, might with advantage have been included in these earlier chapters, leaving its interpretation in terms of the electronic theories to be dealt with in the later and highly controversial sections of the work, where Prof. Lewis develops his own views with the aid of numerous applications both in organic and inorganic chemistry. Some of the electronic formulæ suggested are already well-known and provisionally accepted; others, including many which are novel, will be received with varying grades of satisfaction.

As was to be expected, the electron duplet is in this

book vested with an importance which eclipses that of the octet itself. The author dislikes odd numbers of electrons, and regards molecules such as that of the highly stable and colourless nitric oxide, with fifteen electrons, as obstructionists, like the single player and the three-ball match on the golf links. In this attitude he represents at present a considerable majority of physical chemists; but although this helps to keep speculation within bounds, there are nevertheless some who still feel that they derive advantage from practising in fields where these recalcitrant molecules appear as examples of reactive combinations and not as exceptions to any rule.

The author reconciles Bohr's theory with his own by assuming that the fixed position assigned by him to each electron in the atom represents the average position of the electron in its orbit. This interpretation, however, appears to the reviewer to be an arbitrary one which later on may prove untenable, and which necessarily brings into prominence the magnetic phenomena associated with the movement of the electron. However that may be, the device obviously clears the way for a classification of the elements based on Bohr's system, but always, in the hands of Prof. Lewis, with full acknowledgment to the sources of inspiration.

Where Sir Joseph Thomson relies mainly on forces of the electrostatic type, Prof. Lewis holds that "such forces are responsible neither for the fundamental arrangement of the electrons within the molecules nor for the bonds which hold the atoms together." In the present work, consequently, magnetic moments assume directive or causative functions corresponding with those attributed to electrical moments in the preceding work; it naturally follows that ionisation and numerous reactions which "verge on the ionic type" become not merely limiting cases, but, like molecules containing an odd number of electrons, definite exceptions to the system.

Considerable space is devoted to co-ordination, bivalent hydrogen, ionisation, and strengths of acids and bases. There is much here which is suggestive; but when, for example, Prof. Lewis (p. 107) quotes an opinion that "an aqueous solution of hydrochloric acid would have the properties of a weak acid if it were not for the formation of this hydronium chloride," he is not helpful, for this applies only to the conductivity of the solution and not to its "acidness."

A number of problems of special interest to the organic chemist are touched on, including conjugation, partial valencies, and tautomerism. Huggins's theory (1922) of the electronic structure of benzene, which closely resembles that suggested independently by R. Robinson, in a discussion at the Chemical Society early in the same year, is cautiously commended.

The last chapter, which deals very broadly with the discontinuity of physico-chemical processes, photochemical reactions, colour, and with the future of the quantum theory, displays the prepossessing features of the early sections of the work, which is eminently readable throughout.

The printers and publishers have ably supported the authors of these two works in producing attractive monographs. There appear to be very few errors or omissions. In Sir Joseph Thomson's book, on p. 41, line 26, for "electrons" read "atoms," and on p. 135, line 14 from the bottom, for "proposition" read "proportion"; in Prof. Lewis's book, two dots have inadvertently been omitted from the formula for butadiene on p. 91.

A. L.

Bruce of the *Scotia*.

A Naturalist at the Poles: the Life, Work, and Voyages of Dr. W. S. Bruce, the Polar Explorer. By Dr. R. N. Rudmose Brown. With Five Chapters by W. G. Burn Murdoch. Pp. 316 + 25 plates + 3 maps. (London: Seeley, Service and Co., Ltd., 1923.) 25*s*. net.

MR. RUDYARD KIPLING'S recent rectorial address on "Independence" gave general expression to the problem of those who in thought or action set themselves against the domination of "the Tribe," and here in the Life of Dr. W. S. Bruce we have an example of the career of one who did so. From this point of view, it might be wished that Dr. Rudmose Brown had been led to estimate in how far the "iron ration" on which Bruce relied was fitted to sustain him in his efforts to attain his ideals by his own exertions. Such a life, analysed with full knowledge of temperament, equipment, ambitions, and achievements, might bring enlightenment, help, and warning to others who are setting out on a scientific career. Yet the author was perhaps wiser not to make his biography a critical estimate of character. He has given an honest account of the work of a strenuous life in that spirit of sympathetic friendliness which Bruce inspired in all who knew him. From the facts set out in the narrative portion, read in the light of the two fine concluding chapters, "Ambitions and Dreams" and "The Man and his Work," the reader will not find it difficult to build up for himself an appreciation of the naturalist-explorer who differed in so many ways from the popular conception of a polar leader.

Bruce, when he first came to Edinburgh as a youth of seventeen, was a gentle, pathetic, lovable fellow full of vague visions and fine ideals, and no one suspected

that his shy, compliant nature was capable of holding on with the soft and flexible tenacity of a Chiton to any scheme on which his heart was set. Love of natural history was his dominant characteristic, and it drew him to the field and seashore rather than to the class-room. He completed no course of formal study and took no degree, remaining to the end an observer, collector, and organiser rather than a systematic or specialised man of science.

In a fascinating group of four introductory chapters and one of "Further Recollections," his old friend and companion, Mr. W. G. Burn Murdoch, reveals Bruce's early environment in Edinburgh, where he responded both to the magical stimulus of Prof. Patrick Geddes in science and to the emotional Celtic patriotism then pervading the University Hall where he lived. These chapters also describe the voyage on the *Balaena* to the Weddell Sea in 1892–3, when the spell of the polar regions fell on a mind which never after escaped its influence. After an account of the part Bruce played in the Jackson-Harmsworth Expedition to Franz Josef Land and in other private Arctic voyages, Dr. Rudmose Brown deals, with fuller knowledge than any one else possesses, with the origin, progress, and results of the Scottish National Antarctic Expedition to the Weddell Sea in 1902–4.

The solid results of the voyage of the *Scotia* entitle Bruce to a high place as an Antarctic explorer, though at the time he was rather overshadowed by the fame of the *Discovery*. The inception of the *Scotia* Expedition was his own, the funds for it were contributed by friends in response to his personal appeal; the plan of the cruise and the work done were original, dictated not by any external authority but by his own foresight and the chances which presented themselves in that region of unexpected obstacles and opportunities. How he looked on his assistants is shown by one of the too rare extracts from Bruce's diary on the *Scotia* (p. 148):

"I would like them to regard the ship as their university, as their *alma mater* in the highest possible sense, where they will be able to study the phenomena of Nature, without bias, from Nature itself; and learn that they, as well as their fellows, have many short-comings. I am here as leader rather than commander, in order to guide the work of others, so that the aggregate may be of the greatest possible value to science and the world."

Bruce's pertinacity secured the finest series of deep-sea soundings ever made in the far south, and numerous hauls of the dredge, trawl, and fish-traps in deeper Antarctic waters than any other expedition has investigated. The discovery of Coats Land was scarcely noticed by the public, for though it was a geographical result of the first order, Bruce's indifference to non-scientific opinion led him to make little of it in comparison with his oceanographical work, which interested the newspaper reader very little. The most permanent outcome of the *Scotia* Expedition is the meteorological station established on Laurie Island (61° S.), which, after being organised and kept up for a year by Mr. R. C. Mossman, was taken over and maintained by the Argentine Government.

Though his later years were to some extent clouded by a sense of grievance with the tardy and inadequate assistance rendered by his own Government, Bruce continued to carry on by himself work which would have taxed the resources of a well-endowed scientific institution, but he escaped at frequent intervals to solace himself in Spitsbergen solitudes. He created the Scottish Oceanographical Laboratory, he classified and distributed the abundant collections of the *Scotia*, and made considerable way with the publication of the scientific results of the expedition. Of his struggles in this effort Dr. Rudmose Brown says (p. 252):

"Bruce strained his own scanty means to breaking-point to keep the publications going. The proceeds of lectures, articles and sale of bird skins and eggs were all devoted to the same cause. He had a hard struggle to keep his laboratory open and meet the printing accounts, yet he insisted that all the results should be adequately dealt with and fully illustrated. The one contingency he resisted was the abandonment of his laboratory and his publications. Poverty he was ready to face and did face: only his most intimate friends at the time knew of his struggles. Through all those days he never lost hope. . . . But all his schemes were for the advancement of science; his own interests counted not at all."

Bruce had no expensive tastes or impulses, and only cared for money to enable him to carry on his work: to this his personal life was entirely subordinated. In the end he attained to recognition as the best authority in Great Britain on practical oceanography and polar natural history; all the more is it deplorable that his oceanographical laboratory was broken up in his lifetime, and the collections, in gathering which he had spent his life, dispersed, albeit within the bounds of his beloved Scotland.

Hugh Robert Mill.

Mendelian Inheritance and Eugenics.

Heredity and Eugenics. By Prof. R. Ruggles Gates. Pp. xiii + 288. (London: Constable and Co., Ltd., 1923.) 21*s*. net.

In the space of some 250 pages of well-produced matter, Prof. Gates has devoted himself to an examination of the known facts of human inheritance, with special reference to Mendelian inheritance. According to the preface, a compelling interest in

eugenics and a conviction that statesmen and law-makers alike have failed to realise how fully any intelligent attempt to improve the conditions and qualities of the human race must be founded on a knowledge of the manner in which qualities arise, are inherited, maintained or lost, have driven the author to glean from many sources. Thus he has been able to assemble in the present volume a crowded record of observations on the physical and mental characters of man, the results of the blending of races, the problems of population, and other aspects of eugenics, the main practice of which appears to be the production in the human frame of ready remedies for the evils of our social systems.

A general list of works bearing more or less directly on the infant subject of eugenics, and a bibliography of papers which have largely contributed to the matter of the text, complete the volume, and provide both ample reference for the general reader who would probe more deeply into recorded facts and opinions, and proof of the lively interest which has grown within the last two decades in Nature's laws which make or mar man's prospects from birth.

To maintain a well-born race is a natural aspiration involving no necessarily clear conception of the acme of human development of qualities either physical or mental; for although we cling to a vague ideal of a healthy mind in a healthy body and define more or less clearly the standards whereby we judge our fellow-creatures, there is no guarantee from the long pages of descent that the standards of human well-being for which we strive have kept in motion and in strength the main stream of human life.

It is well to realise how temporary are our aims, and that, in the practice of eugenics, our purposes are moulded more by our social systems than by a wide knowledge of whence man came and how, and of whither he is going and why, in the inexorable drifts of countless generations. To render better the span of life for our descendants is indeed a noble aim, the realisation of which must be based on a study of great tribal trends rather than on the application by one social cast to another of a knowledge of chromosomes, sex-linked inheritance, or the incidence of feeble-mindedness and colour-blindness. For man has come down the ages for good or ill by paths which neither a knowledge of inheritance nor a man-formed scheme of eugenics could have controlled effectively, and so he will go, despite our best endeavours, by the ceaseless drive of world-forces which eugenic practice can never mould to our will.

Much space is devoted in the text of the present volume to such topics as stature, eye-colour, hair-distribution, brachydactyly, and cataract, and to the occurrence of feeble-mindedness among the destitute, musical aptitude, and the limits within which characters of a parent persist in the offspring. But on the vital questions which are ever before us of the origin and meaning of any single character which declares itself in a life-span with a fate to be sealed in descent, there is silence. It is well that this should be fully realised, for it marks much of the current literature on eugenics, and stamps it as a speculation in futures of which we know nothing for lack of knowledge of the past. For Mendelian inheritance, on which eugenic practice so fully rests in its quest for the betterment of the human race, is little more than an elaborate distributing agency which deals in complex characters of unknown origin for which the future is obscure.

The book is well written and adequately illustrated: it will serve admirably as a guide to those who seek an honest statement of the present position of the principles on which the practice of eugenics is being built to-day.

J. McL. T.

Our Bookshelf.

Ultraviolet Radiation: its Properties, Production, Measurement, and Applications. By M. Luckiesh. Pp. xi+258+12 plates. (London: Crosby Lockwood and Son, 1923.) 21*s.* net.

WHEN Scheele in 1777 projected the visible spectrum upon silver chloride, he was on the verge of discovering ultraviolet radiation, but it escaped his attention. Ritter in 1801 noted the effect on silver chloride of what proved to be this new type of radiation. This was the starting-point of a series of discoveries of photo-chemical effects made in the early part of the nineteenth century. The limit of transparency of ordinary glass is in general at about 340 millimicrons. Quartz crystals were found to be transparent as far as 185 millimicrons. Instruments employing quartz made it possible to extend the ultraviolet spectrum greatly, and by using fluorite Schumann extended the explored region from 200 to 120 millimicrons. Lyman placed the light source in an exhausted spectrograph chamber, and by employing a reflection grating was able to extend the known spectrum to about 50 millimicrons. Recently, Millikan has spanned the gap between these short ultraviolet rays and X-rays.

A detailed account of the experimental work that has been done on the subject of ultraviolet radiation is provided in a recent work by Mr. M. Luckiesh of the Nela research laboratories. The author states that his aim is to present authentic data of such scope as to be useful to those who are interested in the subject. Theory has purposely been subordinated to experimental facts because the latter are not affected by the inevitable changes in theory. The result of his labours is to furnish a storehouse of information which will be of service to the chemist, the physicist, the engineer, the biologist, the ophthalmologist, and the physician, for to each this form of energy is of practical value.

After a short introduction and an account of the

ultraviolet light in solar radiation, the subject of transparency of gases, liquids, solids and, in particular, glasses, is discussed in detail. Then follow important chapters on the reflection and production of ultraviolet radiation, in which the many sources now available are described and compared. After describing the detection and measurement of the rays, the author discusses their effect upon living matter and various photochemical actions. Although the reader would have been grateful in some places for a more critical discussion, he must feel that he is indebted to the writer for the large number of investigations described and for the many references.

The Savile Club, 1868–1923. Pp. vii + 206. (Privately printed for the Committee of the Club, 1923.)

This book will not only be welcomed by members of the Savile Club generally, but will also be a source of interest and pleasure to all such "strangers" as may come to read the anonymous author's "round unvarnished tale" of the birth and growth of the club, which has well striven to retain the original characters impressed upon it by the principles laid down by its founders. The founders' desire was, in brief, to establish a club consisting of a "mixture of men of different professions and opinions" by "a careful process of election." The eminently readable and racy story of the Savile's progress that occupies seventy pages of this history, in conjunction with the interesting chronological list of members and committees given in the rest of the work, supplies good evidence that these principles have not been forgotten.

A careful study of the whole of this work, as regards both matter and manner, and especially the apt quotation in the preface from the *Spectator* (No. 34, April 9, 1711), suggest to the present writer a probable clue to its author's identity. Such an author must necessarily be a Savilian of very long standing, and intimately acquainted with many fellow-members. He must, further, have had the habit of going to the club very frequently, and be endowed with mighty memory for details. Added to all this, he must be a genuine devotee to the club's principles and traditions. It is not possible to find in the whole list of members any one but Sir Herbert Stephen who possesses this infinite variety of qualifications. This hypothesis concerning the authorship withstands the application of a crucial test—the spirit and style of this admirably composed record.

Readers of Nature may well take special interest in this book, which shows that the Savile Club has numbered among its younger members a large proportion of those who have become the most distinguished men of science in Great Britain and the world at large.

Electro-Chemistry related to Engineering. By W. R. Cooper. ("A Treatise of Electro-Chemistry," edited by Bertram Blount.) Pp. xiv + 136. (London, Bombay and Sydney: Constable and Co., Ltd., 1923.) 12*s.* 6*d.* net.

Every electrical engineer will admit that the science of electro-chemistry is of vital importance to his industry. All the copper he uses is refined exclusively by electro-deposition, and all the aluminium is produced electro-chemically. The electric refining of steel is now widely used, and so also is the electric production of ferro-alloys. These alloys have enabled wonderful results to be obtained in the construction of aircraft. Supply engineers have to be very careful not to let electricity leak from their mains, as the resulting "vagabond" currents corrode water- and gas-pipes. It is therefore advisable that they should know to what extent their stray currents produce this corrosion, and whether they will corrode reinforced concrete or not. We were particularly interested in the chapter on electrical precipitation of dust, smoke, and fume, and its commercial applications. Unfortunately the costs vary greatly with circumstances, so no general figures can be given; but we think that if the laws regulating the emission of smoke into the atmosphere were made a little more stringent, manufacturers would soon find it more economical to prevent it electrically. The chapter on electro-culture gives excellently and very briefly the present state of the art. Mr. Cooper's knowledge is acquired at first hand. In the final chapter he discusses the relative importance of cheap power and cheap freights. In some countries the cheap power available is more than counterbalanced by the high cost of transport. To scientific workers, and more especially to electricians, this book will prove useful.

In Witch-Bound Africa: an Account of the Primitive Kaonde Tribe and their Beliefs. By F. H. Melland. Pp. 316 + 24 plates. (London: Seeley, Service and Co., Ltd., 1923.) 21*s.* net.

While anthropologists frequently maintain the necessity for insight and sympathy in the administration of the affairs of backward races, it is not often that concrete examples of the peculiar psychology of primitive man are put to the layman so convincingly as some of the instances which Mr. Melland has singled out in this book. As an official of some twenty-two years' standing, he is in a position to speak with authority. From this point of view his book can be recommended heartily to every one interested in the government of our backward races.

On the scientific side, Mr. Melland's account of the Ba-Kaonde of Northern Rhodesia is equally important. The Ba-Kaonde consist of three elements, to which, however, the author gives a common name as a matter of convenience. He is of the opinion that they are offshoots of the Batuba. Some of their customs suggest an affinity with Central rather than South Africa. There is, for example, practically no "bride-price," but the husband stays with the bride's people for a period of from three to ten years, and his children belong to them. As the title of this book suggests, Mr. Melland is much impressed by the importance of witchcraft in the life of the people.

The Cultivation of Sugar Cane in Java: an Elementary Treatise on the Agriculture of the Sugar Cane in Java, and more especially on its Cultivation on the Krian Sugar Estate. By R. A. Quintus. Pp. xii + 164 + 38 plates. (London: Norman Rodger, 1923.) 12*s.* net.

The position occupied by Java as a cane-sugar producing country, and the care bestowed on the cultivation of the crop, ensures a welcome to a book in English dealing with the agricultural methods employed on an important estate in eastern Java. This volume,

written by the manager of the Krian estate, is virtually a text-book of sugar-planting under the conditions obtaining in Java. In addition to its utility as a practical guide, it should prove of interest from the point of view of comparative agriculture, since, in Java, local circumstances call for an intensive form of cultivation which does not obtain in all sugar-growing countries. The fundamental principles of sugar cultivation, however, are the same in all producing regions, and they are clearly set out by the author. There are two sections of the book. The first part, which is introductory, deals with cultural conditions in Java, and affords a discussion on soils, manuring, and the botany of the sugar-cane; while part two furnishes a practical account of the cultural methods adopted on the Krian estate, including operations down to the harvesting and transport of the cane, and deals also with certain aspects of estate administration. The book is excellently illustrated with photographs and coloured plates.

The Theory of Experimental Electricity. By W. C. Dampier Whetham. (Cambridge Physical Series.) Third edition. Pp. xi+349. (Cambridge: At the University Press, 1923.) 12*s.* 6*d.* net.

To students with a limited knowledge of mathematics who desire a sound theoretical basis on which to build we can heartily recommend this book. The author writes in a most interesting and convincing way, and gives an excellent preliminary introduction to the latest electrical theories, as well as a clear account of the apparatus and methods used in an electrical laboratory. He points out that according to the electron theory, matter is an electric manifestation, and so the mass of a body must be explicable as electric inertia. The electric inertia of a magnetic field can be represented as due to the motion of electric tubes of force in the luminiferous ether. In this way electric inertia is in its turn "explained" as "mechanical inertia" of the hypothetical substance invented to enable our minds to form a rational picture of other physical phenomena. The author points out that, in a certain sense, simplification is thus attained. All natural phenomena are referred to the properties of the ether. Nevertheless, the mystery is but changed. We may have explained matter in terms of ether, but how are we to explain ether? The book closes with this question unanswered.

Statistical Method. By Prof. Truman L. Kelley. (Text-book Series.) Pp. xi+390. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 18*s.* net.

This volume by an educationist should be of great service to those who use statistical methods in any field, since it provides a summary of nearly all, if not all, the methods which have been proposed for measuring relationship. This seems likely to be its chief use, but it includes also a discussion of frequency distributions and of Pearson's set of curves, with chapters on index-numbers and other special applications. The study begins with data already collected, but the introductory chapters outline the principles of tabulation and graphical representation. Although problems are suggested in several chapters, the book can scarcely be regarded as a text-book for beginners, being very condensed in many parts, with few worked examples, but rather is a critical survey. In the treatment of correlation much use is made of a symbol for $\sqrt{1-r^2}$ as "coefficient of alienation." Appendices supply a list of symbols used, a bibliography—which is not up-to-date as regards editions of books—and an extended table of deviates of the normal curve. The index is small but useful.

Eastern England: some Aspects of its Geography, with Special Reference to Economic Significance. By John Bygott. Pp. xv+358. (London: G. Routledge and Sons, Ltd., 1923.) 6*s.* net.

In this book the author has attempted with a large measure of success to make a geographical study of agricultural England, devoting his attention to East Anglia and Lincolnshire. The study is comprehensive and thoroughly geographical. In no aspect of the subject does Mr. Bygott lose touch with the effects of location, relief, soil, and climate, and he considers the region in the past as well as the present. The volume rises far above the rank of the ordinary text-book as a serious contribution to the regional geography of the British Isles. There is a little overlapping in places; occasionally condensation would not be amiss; and it might facilitate the use of the book if some of the statistical matter was arranged in tabular form; but these are all minor points, and do not materially detract from a useful volume. The numerous sketch-maps are not the strongest part of the book.

R. N. R. B.

The First Days of Man: as Narrated quite simply for Young Readers. By F. A. Kummer. (The Earth's Story, 1.) Pp. 293. (London: Hodder and Stoughton, Ltd., 1923.) 7*s.* 6*d.* net.

Although this little book does not call for extended notice, it is worth mention as a type of educational work which is more common in the United States than in Great Britain. After a preliminary chapter dealing with cosmic evolution, it gives the main outline of the development of civilisation up to the end of the Stone Age in a logical order and an attractive form suitable for quite young children. In the whole it keeps fairly closely to accepted fact and theory, while avoiding the more formal methods usually adopted in the elementary introductions to the results of archæological study which have hitherto been offered to the British public.

An Introduction to Mining Science: a Theoretical and Practical Textbook for Mining Students. By J. B. Coppock and G. A. Lodge. (Longmans' Technical Handicraft Series.) Second edition. Pp. xi+252. (London: Longmans, Green and Co., 1923.) 4*s.*

This book provides a sound and interesting course in elementary science, from the point of view of the needs of miners. It is clearly written, and is well printed and illustrated. The experiments are carefully described, although it is questionable whether a large class should prepare small specimens of nitroglycerine, and then pour them down the sinks, as directed (p. 186). In the experiment on p. 120, a bit of "compo" tubing is less likely to do damage than glass. The technical matters are well explained, and the book will be useful.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Polarisation of Double Bonds.

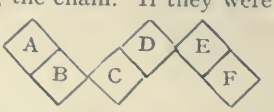
PROFS. LAPWORTH AND ROBINSON in a letter under the above title in NATURE of November 17, p. 722, raise some objections to a theory which I published in the *Philosophical Magazine* in September. The first of these objections is to the difference which I make between the action of an external electric field on singly- and doubly-bonded atoms. It seems to me that such a difference must exist. For, suppose that there is a double bond between two carbon atoms $C_2=C_1$, the octets of electrons round C_1 and C_2 have four electrons in common situated between C_1 and C_2. If an external electric field acts on the molecule, tending to make electrons move from left to right, some of the electrons held in common may be so far displaced from C_2 and towards C_1 that they can no longer be regarded as shared with C_2. If two of these are displaced far enough for this to happen, the octet round C_1 will be intact and C_1 will be saturated, while the octet round C_2 will be reduced to a sextet, so that C_2 will be unsaturated and chemically active; there are still two electrons left between C_1 and C_2 to form a single bond binding C_1 and C_2 together. If there were originally only a single bond between C_2-C_1, the octets round C_1 and C_2 have only two electrons in common; if one of these moves so far towards C_1 that it can no longer be regarded as completing the octet round C_2, so as to make this atom unsaturated and active, there will only be one electron left between C_1 and C_2 to bind them together. We should expect that they would easily come apart and form oppositely charged ions. Thus in this case neither of the carbon atoms would become active chemically while in combination.

Profs. Lapworth and Robinson object also that the effect of electrostatic induction would only be manifest at the beginning and end of a chain, that there would be no poles in intermediate positions. It is, however, only when the chain is entirely uniform that the evidences of polarity would be restricted to its ends. To take a very crude illustration: if we have a number of cubes of soft iron and place them face to face so as to form a uniform bar ABCDEF,

A	B	C	D	E	F

then if this were placed in a magnetic field where the force is parallel to the bar, the poles would be at or near the ends. If, however, they were arranged in diamond fashion,

there would be a series of consecutive poles at equal intervals along the chain. If they were arranged like



there would again be consecutive poles, but the intervals would be different. With regard to the objection that my theory involves Kekulé's structure for the benzene ring, I used this structure in my paper because it was the simplest and most definite. But unless all the carbon atoms in the ring are supposed to be the same in all respects, almost any theory would, I think, lead to analogous results.

Again, Profs. Lapworth and Robinson say that, according to the theory given in my paper, when vinyl chloride is acted upon by hydrochloric acid the result should be ClH_2C-CH_2Cl and not, as I say, $H_3C-CHCl_2$. I cannot agree with this at all. The effect of substituting Cl for H is on the theory to produce an electric field which attracts negative ions. This, it is true, will extend to the carbon atom in vinyl chloride which is not chlorinated, and make it more likely to attract a chlorine atom than it was before the chlorine was introduced. But when another Cl atom is introduced into the molecule the carbon atom to which it goes is determined not by the absolute value of the attraction in one part of the field but by the difference in the attraction. The Cl atom will go to the part of the field where the attraction is greatest, and this will be the part of the field nearest to the chlorine atom which is the origin of the attraction, so that the new chlorine atom will go to the carbon atom which is in this part of the field; that is, it will go to the carbon atom already chlorinated. J. J. THOMSON.

Trinity Lodge, Cambridge,
November 19.

Experiments on Ciona and Alytes.

IN NATURE of November 3, page 653, Mr. H. Munro Fox announces that he did not succeed in repeating my results in his Ciona experiments in Roscoff: amputated siphons regained only their normal length. Mr. Fox supposes that the extra growth in length of the siphons in my experiments was produced by extravagant feeding, and not by the regenerative activities of the animals.

Before Mr. Fox publishes the full account of his work, which he promises, I beg him to note the following facts, namely:

(1) The two principal cultures (operated and control) of my Ciona were placed at the same time and at the same stage of development, with the same provision of food, in two precisely similar aquaria, which stood beside each other. The dimensions of these aquaria were $300 \times 170 \times 100$ centimetres. I did not undertake a quantitative estimation of the number of micro-organisms present; but the food available was, so far as I could see, rather on the scanty than on the abundant side.

All the specimens in the control culture possessed short siphons, and therefore the influence of food on the length of siphon is excluded.

(2) I am not the first and only observer who has noted the "super-regeneration" of the siphons after they have been cut off several times. Mingazzini [1] asserts that siphons amputated three or four times at intervals of a month became longer after each regeneration. Mingazzini was able in this way to produce artificially the local variety, "macrosiphonica," found in the Gulf of Naples. I fully anticipated that the decisive experiment on regeneration and inheritance in Ciona would encounter violent contradiction. On that account I took care to construct this critical experiment out of experiments which had already been made by other investigators. That this was possible in the case of Ciona was one of the reasons which led me to choose this species. Indeed, I have had a predecessor (E. Schulz) also on the question of the regeneration of the "Keimplasma" out of somatic material, though his experiments were made not on Ciona but on another

[1] "Sulla regenerazione nei Tunicata," Bolletino Soc. Nat. Napoli, Series I., year 5, 1891. (An abstract of this paper appeared in the Naples *Zoologischer Jahresbericht* for 1891 under the head "Tunicata.")

Ascidian (Clavellina). The only originality which I claim is the combination of *well-known* experiments and their application to the solution of a problem of inheritance.

Barfurth,[2] after he had discovered (at that time in his laboratory at Dorpat) that the limbs of frog-larvæ had the power of regeneration, laid stress on the superiority of one positive result as against any number of negative results. "Even if only Dorpat tadpoles regenerated their limbs, nevertheless his result would be established." I make the same claim for Ciona, "even if only Ciona from Naples and Trieste grow long siphons." Finally, have perhaps only southern populations this power?

I make use of this opportunity to refer also to NATURE of September 14, in which Dr. W. Bateson writes again on the subject of Alytes. The type specimens of my experiments are in the Museum of Experimental Development attached to the Biological Institute of Vienna, and are the property of the Museum. I communicated Dr. Bateson's proposal to the directorate, and added, as my own opinion, that I was not in favour of exposing the critical specimen of Alytes with nuptial pads to the dangers of a second journey, only because Dr. Bateson had neglected the opportunity of examining it when he was able to do so. Nevertheless, I did not oppose a veto to the directorate sending the specimen if they wished to do so.

I was formerly very generous in lending type-specimens, but I have unfortunately had very unfavourable experiences in so doing. PAUL KAMMERER.

Vienna, November 10.

[2] "Sind die Extremitäten der Frösche regenerationsfähig?" *Arch. Entw. Mech.*, vol. 1, 1894.

Problems of Hydrone and Water: the Origin of Electricity in Thunderstorms.

As one of my younger sons remarked to me some time ago—it is impossible, in these days, to get up a scrap! I challenge the current explanation—we cannot yet call it a *theory*, but, again, in these days, no one has care of words, every one calls his pet notion a theory—of the origin of the electricity let loose in thunderstorms, raising thereby an entirely fundamental issue. Yet no one dare face the problem. In these days, we have no regard for fundaments; our care is only for the chimney-pots; we devote ourselves to polishing these, forgetting that often the foundation of the house is yet to be built. I privately challenge the Sage of Salisbury, who formerly took some interest in electrical phenomena and lightning conductors and deigned to consort with us weak chemical vessels; his reply is proof that he has not seized my point and is "up above the world so high" that he cares only to contemplate electrons in transcendental garb, not in that of the vulgar raindrop. Big as he is, he has wrapped himself up snugly within the atom and won't consider what happens between at'ems—when they are molecules and interact.

I am sorry if I have depressed Dr. Simpson (NATURE, Oct. 27, p. 620). I well know that he bases his conclusions upon the experiments he has made. Unfortunately, from the sad experience of fifty years, I know that the results of experiments are often to be interpreted in opposite and equally plausible ways. Lenard and Dr. Simpson, so far as I am able to judge, have made experiments on very similar lines; the conclusions at which they arrive are different, however; rain, too, is sometimes negative, sometimes positive. I ask that exact stock may be taken of the work, and that we may know precisely what it is that has been measured. The feeling is upon me that the circuits dealt with were not so simple as is supposed.

We chemists are in grave difficulty. Physicists seem not only unwilling but also unable to grasp the spirit of our work; we are, therefore, forced to dabble in their field and naturally feel far from safe in dealing with electrical problems—though some of us have no hesitation in pronouncing on the electrical in'ards of the atom. If the physicists had sympathy with us, they would long since have tutored us and not allowed us to talk the nonsense we have indulged in, all these years, on the subject of ionic suicide in solution.

I am really posing a problem far deeper than that considered by Dr. Simpson. Whether energy be let loose in the division of big raindrops or when small ones unite matters relatively little to me—what I first want to know is whether, in such a liquid circuit, the energy would appear otherwise than as heat; whether, in fact, electrical energy can get loose from an electrodeless liquid circuit. This seems to me to be one of the fundamental problems to be solved in connexion with chemical change in solutions. The fire is a far more potent display of energy than a rain shower, yet we have no evidence of electricity being stormily loosed from it, however strong the draught up the chimney. I would beg for a Roland from Sir Oliver in this connexion: if he cannot meet me, I would ask some other Knight Physical to make his proclamation on the issue I have stated or, in some way, confound my inconvenient, if not improper, curiosity concerning an ordinary but always entrancing phenomenon. As to an external source, ultra-violet radiation must be doing something in the upper atmosphere. HENRY E. ARMSTRONG.

The Gorilla's Foot.

SINCE I have examined and sketched the feet of one or two dead gorillas in the Zoological Society's Gardens, may I be permitted to say that no one acquainted with the foot of this ape can dissent from Sir Ray Lankester's condemnation (NATURE, November 24, p. 758) of the photograph of the cast of the foot of the Kivu specimen published by Mr. Akeley? The photograph successfully conceals the fundamental resemblance, so far as mobility is concerned, between the hallux of the gorilla and that of monkeys, and suggests a resemblance, which does not exist, between the hallux of this ape and of man. It is, therefore, entirely misleading; but it is quite in keeping with Mr. Akeley's statement that the big toe in the gorilla "has grown away from the thumb, which is useful in climbing, towards the big toe, useful for walking" (*World's Work*, October 1922, p. 377).

Without any reflection being cast on Mr. Akeley's *bona fides*, that statement may be dismissed as incorrect, and as attesting the author's unfamiliarity with the structure of the gorilla's foot. Admittedly the hallux of the gorilla, like that of any monkey, can be stretched forwards so as to lie in contact with the adjoining edge of the next toe; but it cannot take up that position without forming a long and deep integumental crease on the sole of the foot. To the failure of Mr. Akeley's cast to reproduce this crease, showing the mobility of the hallux, must be mainly assigned the fictitiously human appearance of his photograph of the gorilla's foot. It is to be hoped that the duplicate cast will not be exhibited in the Natural History Museum without a label clearly explaining this misleading defect. R. I. POCOCK.

November 26.

NOTE.—While this letter was in the press, I saw at the Natural History Museum the duplicate cast above referred to. It shows quite clearly the deep crease mentioned; and the deceptive photograph would have revealed it, if proper attention had been paid to the direction of the light.

November 29.

Colour Vision and Colour Vision Theory.

In his letter on this subject which appeared in NATURE of September 29, p. 473, Dr. Edridge-Green apparently promised to deal with my explanations when these were given. In reply I selected two in which the full reasoning had been given, and I invited him to implement his undertaking. In his letter in NATURE of November 10, p. 687, he apparently declines to do so, and passes his burden on to the reader.

In none of his letters has Dr. Edridge-Green attempted to discuss my proofs, or indications of the proofs; but on the contrary he has in each letter merely made fresh assertions of other cases in which he presumes similarly that the trichromatic theory is incompetent. Nevertheless, ignoring the absence of discussion on his part, I took up each fresh assertion as it came, and dealt with it as with those which preceded. In his present letter he repeats the process, bringing forward three new cases. Since, in one of these, he deals with a statement of mine ("Colour Vision," p. 151), I shall, as before, discuss these new examples also, though that procedure cannot be continued indefinitely.

He seems to agree that my explanation of the absence of shortening of the spectrum at the red end after fatigue by yellow light is sound if the presumption made be true. But he asserts that the presumption is inconsistent with the work of König, Abney, and others. The presumption is that all three sensations are stimulated by visible light of any wave-length. Now Dr. Edridge-Green is wrong in asserting that this presumption is inconsistent with the *work* of König, Abney, and the others. It is certainly inconsistent with the *presumption* made alternatively by these investigators, which implied that the red sensation alone was stimulated by light near the red end of the spectrum. But the *work* never proved the correctness of that presumption, which, like the other, was quite a legitimate one nevertheless. For all conclusions regarding colour mixture, obtainable by one set of fundamentals, are necessarily obtainable by any other set linearly related thereto. The only type of work, by which discrimination between two otherwise suitable sets of fundamentals is possible, is work which deals with phenomena related to the sensations by a non-linear law. That condition was apparently unknown to Abney, and so he adopted the not necessarily true view that his selected fundamentals were absolute. They are certainly very convenient for observational work.

Dr. Edridge-Green then says that my explanation does not explain why there *is* shortening of the red end of the spectrum after fatigue by *red* light. Now that is an entirely separate point to which my explanation was not directed. But the trichromatic explanation thereof is quite simple and straightforward. The theory never asserts that lights of two different wave-lengths (yellow and red lights in the present case) will necessarily produce the same fatigue effects in any given region of the spectrum. The law of fatigue is not yet known, but the fatigue parameters used in the trichromatic theory are adequate fully to express it whenever they are formulated as functions of the various conditions which can affect fatigue. It is the absence of recognition of these and similar features of the moulding of the trichromatic theory which has led Dr. Edridge-Green into the erroneous statements unfortunately made by him so frequently regarding the powers of the theory.

Dr. Edridge-Green next raises another new point in saying that I do not "explain Shelford Bidwell's crucial experiment, namely, that his red borders are not seen with spectral yellow light but are seen with a mixed yellow made up of red and green matching it." Now Bidwell's experiment is in no sense crucial. The trichromatic theory has no *a priori* expectation that a pure yellow light and a mixed yellow light shall have the same effect with regard to border colours any more than it has with regard to fatigue. That is entirely dependent on the *nature* of the actions and interactions which are involved, a question on which the theory makes no fixed foregoing pronouncement. It is a matter for physical and physiological investigation. When that inquiry is settled, the theory will incorporate the result as an aid to the formulation of the parameters in terms of known quantities, just as in the case of fatigue discussed above. The theorist welcomes Bidwell's observations, and he is willing to give a similar welcome to those made by Dr. Edridge-Green.

The third and last new case is in the same position. Dr. Edridge-Green cites the gradual disappearance of the positive after-image of a spectrum, which proceeds successively from the red to the violet end. He says that the trichromatic theory states that the positive effect of the red sensation disappears before that of the green. The statement applies if we adopt (say) Abney's fundamentals, but might require modification otherwise. Yet that is not of any essential importance. But he proceeds to say that, "in an absolutely dark room, if pure spectral yellow light be thrown on a white screen and a flicker apparatus rotated slowly in front of it, the yellow will not change its hue; on the trichromatic theory it should become green. The results are quite different when stray light is allowed to fall on the screen as well." Now, while the trichromatic theorist will welcome any such verified data, he cannot admit any compulsion towards the expectation that the colour should become green. The conditions of the retinal illumination are entirely different in the two cases. So the results of the observations can only furnish information regarding the manner of variation of the decay parameters and of the threshold values as functions of the illumination and its duration and its quality, of the length of the rest interval, and also of the areal distribution of the illumination.

I am glad that Dr. Edridge-Green has brought forward these three examples, for they are typical of many cases in which the views of writers on the subject have been adversely affected by the stereotyping of ideas which, while being appropriate enough to the strong restrictions properly imposed in the earlier stages of the theoretical development, have long since been removed. W. PEDDIE.

University of St. Andrews,
November 10.

Late Fertilisation and Sex-Ratio in Trout.

MRSIC[1] has shown that in rainbow trout late fertilisation—*i.e.* the retention of ova within the body of the female after they are fully ripe—results, as it does in frogs (Hertwig,[2] Kuschakewitsch[3]) in an increased percentage of males in the offspring. This is due (as also in frogs—Hertwig[4]) to the transformation into males of some of the young animals which had started to develop as females. The only difference between the frog and the trout is that, whereas in the former case the short period of 4 days' delay will cause *all* females to become transformed

[1] Mrsic, 1923, *Arch. Entw. Mech.*, 98. 129.
[2] Hertwig, R., 1912, *Biol. Centralbl.* 32.
[3] Kuschakewitsch, 1910, "Festschr. f. R. Hertwig," 1910.
[4] Hertwig, R., Sitz. Bayr. Ak. Wiss., 1921.

into males, in the trout a much longer period, in fact the utmost which the female parent will stand —21 days' delay—will only raise the proportion of males to about 67 per cent.

Working with the brown trout with shorter (4-14 days') periods of delay, I have obtained results of the same kind but not so marked.[5]

It was thought that it would be interesting to try the effects of delay outside the body. Accordingly, on December 13, 1922, all the ova of a large female brown trout were stripped into a basin. One portion (lot A) were fertilised immediately. The rest of the eggs were left in the basin, in the small amount of fluid which comes away with them, but without the addition of any water, although in a moist atmosphere. A second lot (B) was fertilised 2 days later, and a third and final lot (C) after a total delay of 4 days. The sperm of the same male was used for all three fertilisations.

The surviving young trout were preserved in October 1923. All which had died after hatching were also preserved, and all but 4 of these could be sexed.

The results may be tabulated as follows :

Lot.	Total ova fertilised.	Died before hatching.		Died after hatching.			Killed Oct. 1923.		Total sexed.		
		% of ova.	No.	% of hatched.	No.	% ♂.	No.	% ♂.	No.	% ♂.	P.E.
A	351	10·3	36	26·7	84	48·7	231	51·1	315	50·5	±1·90
B	286	55·2	158	64·1	82 (78 sexed)	48·7	46	47·8	124	48·4	±3·03
C	208	65·4	136	56·9	41	36·6	31	58·1	72	45·8	±3·52
Total	845	39·1	330	40·2	207 (203 sexed)	46·3	308	51·3	511	49·3	±1·49

None of the variation shown by these male percentages is statistically significant. For example, the difference between the ♂ percentages of A and B (totals sexed) is 2·1, with a P.E. of ±3·39 ; and that between those of A and C is 4·7±4·06. Even that between those for "C, died after hatching" and "C, killed Oct. 1923" is only 21·5±7·84, and must therefore be treated as an error of random sampling. Thus the treatment has *no effect* upon the sex-ratio.

The mortality rate, on the other hand, is markedly affected by the treatment. This is especially notable in the death-rate before hatching ; but even after hatching, although the controls show the abnormally large death-rate for the first ten months of 26·7 per cent. (due to an exceptionally bad attack of fungus-disease), that for the treated ova is more than twice as great. Mrsic (*loc. cit.*) found that over-ripeness within the body of the female exerted a deleterious effect upon the young fish, as had been previously shown for frogs by Witschi.[6] But in neither case was the mortality nearly so great as in these experiments. The increased mortality was thus merely something incidental to any abnormal treatment ; but the two treatments, of delay inside and delay outside the body, exert quite different effects in other respects upon the unfertilised ova.

The sex-ratio of adult (2- and 3-year old) trout, both brown and rainbow, reared in captivity is, I am informed by Mr. Stevens, Manager of the Midlands Fishery at Nailsworth, close to 66 per cent. ♂♂ in his experience. What brings about this marked increase in the number of males is not known (in all recorded experiments the sex-ratio of young fish 6-10 months old is close to 1 : 1). Differential elimination of females after attaining maturity would appear to be the only method by which it could come about, but the reason for this remains obscure.

I should like to take this opportunity of expressing my thanks to Mr. Stevens, without whose interest and help I could not have carried out the work. The expenses were defrayed out of a grant from the Royal Society.

JULIAN S. HUXLEY.

New College, Oxford.

P.S.—I have just heard from Mr. Rowland Hazard, the owner of one of the largest trout hatcheries in the United States, that the sex-ratio of adult fish in his experience varies considerably from year to year. This year it has been about 58 per cent. ♂♂ in 40,000 fish, but in most years the excess of males is less.

[5] Huxley, 1923, *Science*, 58. 291.
[6] Witschi, 1922, *Biol. Zentralbl.* 42. 97.

Is the Pentose of the Nucleotides formed under the Action of Insulin ?

We have read with interest the letter from Mr. C. Berkeley in NATURE of November 17, p. 724. Referring to the substance found in animal tissues after insulin, which gives the α-naphthol reaction, but is without reducing action on copper salts, he suggests that our failure to find reducing power after hydrolysis by acids may be due to a pentose constituent going over to furfural and being lost by volatilisation.

There are reasons which make it unlikely that this is the case. We find that on boiling a solution of the substance in the presence of 8 per cent. hydrochloric acid for three hours, there is no measurable change in the optical properties of the solution. This does not exclude the possibility of loss of pentose sugar owing to conversion to furfurol, since the optical properties of the residue may have been altered, with the result that no change would be observed. On the other hand, the substance gives little indication that it contains a pentose. The modification of the α-naphthol test in which strong hydrochloric acid is used in place of sulphuric would be likely to indicate the presence of pentoses, by a rapid appearance of a purple colour.

Using this test, a positive reaction is obtained only shortly after the sugar has been extracted from the tissue, and then only faintly. The substance is dried with difficulty at room temperature *in vacuo* over sulphuric acid. At the end of this period the α-naphthol reaction (using sulphuric acid) is given with diminished intensity, and in the course of weeks it may disappear entirely. The α-naphthol test is extremely sensitive, and since many proteins and their derivatives give a positive reaction, it is perhaps necessary to emphasise that the intensity of the colour given by the substance in question, as well as the method of extraction employed, point to the substance being of a true carbohydrate nature. Indications have been obtained that the substance is present in normal tissues.

Dudley and Marrian (*Biochem. Jour.* 17, p. 435, 1923) have shown that glycogen disappears almost entirely from the liver and muscles after insulin convulsions. The fact that the blood sugar of animals in convulsions may be restored to the normal level, and the animals be recovered, by injection of such substances as adrenalin or pituitrin, without injection of glucose, suggests that the carbohydrate reserves of the body have been converted into some form other than glycogen. That the Islets of Langerhans tissue contain unusually large amounts of pentose compounds is of great interest ; but this

fact need not lead to the conclusion that the function of insulin is to convert the sugar reserves of the body into pentose derivatives.

L. B. WINTER.
W. SMITH.

Biochemical Laboratory,
Cambridge.

Fixation of Human Embryological and Cytological Material.

IT is known that it is very difficult to obtain well-preserved human material. Few medical men realise that five or ten minutes after the tissue has been removed, or after death, plasmolytic changes supervene, and in the fixed and stained sections the chromosomes have clumped badly, and the delicate lipoid cytoplasmic organellæ have become abnormal, or completely macerated. Recently, I have been studying certain human material, and find that nearly every type of histological preparation can be made from two fixing fluids as follows: one of the surgeon's assistants is given two bottles, one of Da Fano's cobalt nitrate formalin fluid, and one of Regaud's formalin-bichromate fluid. Pieces of tissue as large as the thumb may be thrown into these bottles, and afterwards cut into smaller pieces when they have been brought to the laboratory. It is better to change into new fluid at once, especially if the organ is very vascular, and the fixing fluid mixed with blood.

For human material I find that fixation overnight in the Da Fano fluid gives the best results. Next morning some of the pieces are taken through as usual for Da Fano's method ("Microtomists' Vade-mecum," p. 437), but other pieces are washed in distilled water for ten or fifteen minutes and transferred some to 2 per cent. OsO_4, others to Champy's fluid (chromeosmium). The OsO_4 pieces are used for the Sjövall method (*ibid.* p. 331). From this batch of material, originally fixed in Da Fano, one gets sections which generally show the inner Golgi apparatus (Da Fano and Sjövall), the mitochondria (chromeosmium and sometimes Sjövall), neutral fat and lipoids (chromeosmium), and general nuclear structures and mitochondria (Da Fano fixation, staining in iron hæmatoxylin).

The other batch of material, fixed in Regaud's formol-bichromate, is partly carried through for the Regaud-Bensley-Cowdry method (*ibid.* p. 324), but other pieces of tissue are taken through Schridde (*ibid.* p. 325). These methods give the mitochondria (Regaud), mitochondria and fat (Schridde), and such sections stain nicely in safranin—light green, and in Mann's methyl blue eosin. For secretion and excretion granules, zymogen, yolk, fat, Golgi apparatus, and mitochondria, these two batches of material will give complete results.

For chromosomes, a batch of material in some Bouin formula (*ibid.* p. 306) is recommended.

J. BRONTË GATENBY.

Zoological Department, Dublin University,
November 7.

Linnean Nomenclature.

IN the admirable review of Dr. Daydon Jackson's "Linnæus" (NATURE, November 17) there is one paragraph (last on p. 715) from which I am not sure that I extract all the meaning. This may be because I am a systematic zoologist and not a botanist; but I did begin my work on those lines with the study of Linné's "Philosophia botanica." That book taught me that the *nomen triviale* was no entity, merely a part of the *nomen specificum*, which consists of the *nomen genericum* qualified by the *nomen triviale*. Thus, "man" being the genus, "a good man" is the species; but "good" cannot stand apart from "man," for it is relative to "man" alone. Now take your good man and make him an admiral; he may be a bad admiral. Is that what the reviewer means? Does he imply that, if a species be rightly transferred to another genus, the *nomen triviale* is open to change? If this be his meaning, then it seems to ignore the distinction between a mere name and an epithet. When Jane Smith marries John Brown, she becomes (by custom) Jane Brown. She may thereby even change her nationality, but she remains Jane, and that is how we identify her, although "Jane" by itself is meaningless.

What then, some of us are asking, are the "philosophical positions" from which we have retreated; what are the "sound scientific principles" we have abandoned?

F. A. BATHER.

I REGRET to learn that one of my remarks has proved obscure to zoologists. A note by Linnæus that *nomen specificum sine generico est quasi pistillum sine campana* is accompanied by a cross reference to the denominational canon *nomen specificum sine generico est quasi campana sine pistillo*. The generalisation of the exemplar lends emphasis to the axiom embedded in the canon. That axiom was almost universally accepted by botanists in Great Britain until 1905, when representatives of their science, in international congress assembled, decided by a majority vote that the two portions of a *nomen specificum* may receive differential treatment. I am satisfied that, in reaching this conclusion, the botanists who constituted the majority when that vote was taken abandoned sound scientific principles and retreated from a philosophical position secured by Linnæus for botany. It may be that zoologists regard as justifiable the botanical practice which ignores the axiom accepted here until 1905; if so, there is no more to be said. But, that further misunderstanding be avoided, I may explain that I accept the principle of government by majority: whatever be the merit in civic life of conscientious objection and passive resistance, I regard both as unsuitable methods in descriptive science. This does not deprive me of the right, when dealing with the teaching of Linnæus, to express my conviction that the practical application of a particular Linnean canon which prevailed before 1905 was sound, and that the alternative practice, which obtains in botany to-day, is less satisfactory. I may add that I have not had in mind any of the methods in use in the denomination of individuals, but the teaching of an English naturalist, contemporary with Linnæus, in respect of analogous reasoning.

THE REVIEWER.

Bessemer Steel.

IN a review in the issue of NATURE of November 17, p. 716, of the second volume of Roscoe and Schorlemmer's "Treatise on Chemistry," the following sentences occur:—"The revisers have been perhaps a little too careful in retaining old matter in the text. The full details which are still given of the Leblanc soda process and of the Bessemer process for steel are really of historical interest only now that the last Leblanc plant and Bessemer converter have been shut down."

I have consulted the Statistical Bulletin of the National Federation of Iron and Steel Manufacturers, which gives the official figures of steel production in Great Britain at the present time, and I find that in

September 1923, 37,000 tons were manufactured by the acid, and 9000 tons by the basic Bessemer process. Very large quantities of basic Bessemer steel are being made in Germany and Belgium at the present time.

So far, therefore, as the above quotation relates to the Bessemer process, it is entirely inaccurate and the revisers are quite justified in giving details. The funeral of the Bessemer process has frequently been predicted, but it has never taken place.

H. C. H. CARPENTER.

Royal School of Mines,
South Kensington, London, S.W.7,
November 19.

PROF. CARPENTER is evidently right, and I am glad that he has corrected my mistake in reference to the Bessemer converter,—the statement as to the Leblanc process was, I believe, correct. It would be of interest, however, if Prof. Carpenter could give the date of construction of the last new Bessemer plant erected in Great Britain for steel manufacture. If new plants are not being constructed, the view that the Bessemer process for steel is really "of historical interest only," would not be altogether unjustified, since this process would then rank, like the hansom cab, as one of the products of the Victorian age, of which the usefulness is likely to diminish rather than to increase in the twentieth century.

THE REVIEWER.

The Spectra of Fifth Group Metals.

WE have photographed the absorption spectrum of bismuth and also the spectrum of the thermionic discharge at potentials ranging between 4 and 60 volts. Several stages in the excitation of the arc spectrum, and at least two classes of spark lines, have been recognised; 64 arc lines have been classified. The spectrum of the neutral atom is characterised by wide doublets, and most of the energy-levels so far identified are of p-type.

Electrical measurements of the arcing potential and potentials of inelastic impact were made by two of the authors and the late Dr. Oswald Rognley in 1918. They found inelastic collisions at intervals of $2\cdot0 \pm 0\cdot2$ volts and ionisation at $8\cdot0 \pm 0\cdot5$ volts. The interpretation is as follows:

The first resonance potential, 2·0 volts, represents the mean of the excitation voltages for several weak spectral lines of the type $mp - np'$. At 4·0 volts, we obtain the strong *raies ultimes*, λλ 3067 and 4722 Å.U. Excitation stages above 5 volts are difficult to separate. The first spark spectrum appears near 14 volts.

The absorption spectrum at 800°–1000° C. shows lines due to the atom, and prominent bands which have not been described previously. A group of seventeen bands lies between 2874 and 2672 Å.U., while a second group extends from 2205 Å.U. toward shorter wave lengths. At lower temperatures the bands disappear though the lines still may be recognised. They lie at 3067, 2276, 2230, 2228, and 1954 Å.U., and all originate on the lowest energy-level of the atom. No absorption lines arising from other levels were observed, even at a temperature of 1050° C.

Practically all the arc lines of arsenic between 3119 and 2000 Å.U. can be classified by means of constant differences found by Kayser and Runge (*Ann. d. Physik*, v. 52, 1894). We have discovered a few additional classifications. This spectrum is remarkable in that it possesses no lines in the visible region. There is a range of 38,000 cm.$^{-1}$ and another of 32,000 cm.$^{-1}$ in which no energy levels have been found. If there are energy levels in these regions, they can probably be detected only by the discovery of new lines, or the utilisation of lines at present listed in the spark spectrum. The potential of inelastic impact, 4·7 volts, given by Foote, Rognley, and Mohler (*Phys. Rev.*, 13, 59, 1919) corresponds to the mean of the wave numbers of the *raies ultimes*. The classification of the spectrum shows that the ionisation potential must be at least 10·6 volts, while the experimental value is 11·5 volts.

ARTHUR E. RUARK.
F. L. MOHLER.
PAUL D. FOOTE.
R. L. CHENAULT.

Bureau of Standards, Washington, D.C.,
November 8.

Tracts for Computers.

I REGRET that certain errata have been found in No. III. of the above Tracts. As they might cause confusion to any one computing from one of the formulæ affected, I have had an erratum slip printed, which can be obtained by purchasers of the above series by sending a stamped and addressed envelope either to Mr. C. F. Clay, Cambridge University Press, Fetter Lane, E.C.4, or to The Secretary, Biometric Laboratory, University College, Gower St., W.C.1.

KARL PEARSON.

Biometric Laboratory,
University College, London,
November 17.

Mesozoic Insects of Queensland.

LEST the reference in NATURE of July 7, p. 20, to Queensland Geological Survey Publication, No. 273, may lead readers to think that the account of the Coleoptera is the first published work on the insects from the six-inch seam containing insect remains at Ipswich, I would point out that a series of papers dealing with these insects has already been published by Dr. R. J. Tillyard (Queensland Geol. Survey, Pub. 253, 1916; and "Mesozoic Insects of Queensland," Nos. 1 to 9, Proc. Linn. Soc. N.S.W., 1917 to 1922).

A. B. WALKOM,
Secretary.

Linnean Society of New South Wales,
Sydney, October 2.

[The paragraph to which Dr. Walkom refers was intended to direct attention to a particular piece of work, and no attempt was made to mention earlier publications on the same subject, though the contributor was familiar with them.—EDITOR, NATURE.]

Hafnium or Jargonium.

THE recent discovery of hafnium in minerals containing zirconium serves to remind us of the discovery of jargonium by Sorby in 1869 (*Chem. News*, vol. 20). He found that many zircons contained as much as 10 per cent. of the new element. The two closely-related elements, zirconium and jargonium, could be most readily distinguished by spectroscopic methods. Sorby and Forbes found that there was such a marked difference in the solubilities of the chlorides in strong hydrochloric acid, that it was possible to make a qualitative separation. Three years later Cochran investigated this subject and suggested that zirconia and jargonia were identical. My object in bringing this matter before readers of NATURE is to suggest that the work of Sorby may possibly entitle him to rank as the discoverer of the new element of atomic number 72, and that jargonium may have priority over hafnium and celtium.

T. L. WALKER.

University of Toronto.

Solid Solutions and Inter-Metallic Compounds.

By Dr. WALTER ROSENHAIN, F.R.S.

METALLURGICAL research during the past twenty years has been largely devoted to the study of alloys, and as one result we now possess a series of more or less complicated equilibrium diagrams representing the constitution of most of the binary and of some of the ternary systems. While, on one hand, increasing accuracy of methods has rendered these diagrams far more complex than was at first supposed, a careful examination of those which are most thoroughly established suggests that, widely as they vary among themselves, there are certain regularities which point to some common fundamental principle which, if once grasped, would exhibit these varied diagrams as parts of an intelligible whole. Fortunately, at the time when this great mass of disconnected knowledge lies awaiting synthetic treatment, the results of X-ray analysis applied to the study of the inner structure of crystals have become available. As the result of an endeavour to apply these results to the explanation of the behaviour of alloys systems, the writer has arrived at a theory which, on a simple basis, promises to afford an easy explanation of many, if not of all, of the properties of alloys, and to afford a much deeper insight into the nature of solid solutions and of inter-metallic compounds, and through them to throw new light on the nature of inter-atomic relationships.

The theory in question has been fully stated in two recent papers, and need only be briefly summarised here.[1] A metallic solid solution is an aggregate of crystals which, when in equilibrium, are homogeneous in composition, so that both the solvent metal and the solute metal are present in the same proportions in all the crystals. The present theory of the constitution of such crystals is based on three fundamental principles, the first of which has now received considerable experimental verification, while the other two appear to follow almost unavoidably. The first is that a solid-solution crystal is built up of the two kinds of atoms, those of the solvent and of the solute, upon a single space-lattice which is, substantially, that of the solvent, so that the atoms of the solute may be regarded as being simply substituted for an equal number of atoms of the solvent on the "parent" lattice. Measurements of the lattice-constants of certain groups of solid-solution alloys and comparison of the results with the measured densities of the alloys have strongly confirmed this view. The evidence already obtained indicates that this is the inner structure of practically all inter-metallic solid solutions, but some room for doubt may still exist in regard to certain metalloids, such as carbon or phosphorus.

Next, in a crystal built up in this manner of two kinds of atoms upon a single, simple space-lattice, the inference can scarcely be avoided that a certain degree of distortion of the lattice must result. The nature of this distortion must depend upon the character of the two kinds of atoms concerned; there may be either expansion or contraction of the parent lattice, and this may be either mainly local or mainly general. The degree and nature of this distortion will depend upon the extent to which the solute atom differs from the solvent, and also upon the general character of the solvent lattice, but these are details which need not be considered here. We may pass on to the third fundamental conception—that the extent to which any given space-lattice can be distorted, and particularly expanded, is strictly limited—that there is, in fact, for each pair of atoms a limiting distance beyond which the bond between them—whatever its nature—ceases to act. This rule of a limiting maximum lattice constant or parameter leads to a series of interesting inferences. Thus, a uniform undistorted lattice of a pure substance will be uniformly expanded by heat until the limiting parameter is attained; at this point the atoms throughout the lattice will lose their power of cohesion and the crystal melts. In a solid solution crystal, the lattice may be locally expanded by the presence of solute atoms; under thermal expansion those expanded regions of the lattice will reach the limiting parameter at a temperature where the less expanded portions of the lattice are still well below the limiting value; the result will be commencement of fusion in those regions of the crystals richest in solute and the formation of a liquid richer in solute than the remaining solid. This consideration explains why, in solid solutions, we generally find a melting range instead of a single melting point. Where the solute atoms cause expansion of the lattice the melting temperatures will be depressed by successive additions of solute. On the other hand, where the presence of the solute atoms causes a contraction of the solvent lattice, there will be a rise of melting point and the first liquid to be formed on fusion is richer in solute than the residual solid. These latter inferences have been strikingly verified in such cases as those of solid solutions formed by the addition of palladium to silver or of nickel to copper.

A considerable number of further inferences can be drawn from the three fundamental principles of the present theory of the inner structure of solid solutions—for example, the striking inverse relationship which is found to hold between the solubility of one metal in another and its hardening effect upon it, and the relationship between the hardness, high melting point, and high elastic modulus of a metal on one side and its power of forming solid solutions on the other. The theory has even made it possible to suggest an explanation of the properties of metals and alloys in regard to electrical conductivity. Whatever the true mechanism of electric conduction, there can be no doubt that it is associated with the movement of electrons through the metal; it is now suggested that where the atoms lie on perfectly straight lines on the space-lattice the movement of electrons is entirely unhindered and the metal in that state should exhibit super-conductivity. This can only be fully realised very near the absolute zero, since at higher tempera-

[1] "Solid Solutions," Second Annual Lecture of the Inst. of Metals Division, American Inst. Mining Engineers, New York, Feb. 1923; and "The Inner Structure of Alloys," Thirteenth May Lecture to the Inst. of Metals, London, May, 1923. Journ. Inst. Metals, 1923, ii.

tures the thermal agitation of the atoms disturbs their perfect alignment even in a pure metal. Since it is sufficient for one line or at most a few lines of atoms to be perfectly straight at any given instance—since such a single line would conduct infinitely well—super-conductivity must set in at a temperature slightly above and not only at actual absolute zero. In a solid solution crystal, however, the atoms can never attain perfect alignment, owing to the lattice-distortion, and consequently the electrical conductivity of a solid solution will always be relatively very low, and even at absolute zero, real super-conductivity cannot occur. Further, since the solid-solution lattice is considerably distorted to begin with, the disturbing effect of thermal agitation will be relatively much less than in a pure metal; in certain circumstances, indeed, thermal expansion may partially relieve the distortion —in those cases, in fact, where solid solubility increases with rising temperature. Consequently, in solid solution alloys the temperature coefficient of electrical conductivity will be much lower than in pure metals, while in some special cases it may even become negative. The theory, as comparison of these inferences with well-known facts at once indicates, offers at all events a good qualitative explanation, and at a later stage even quantitative prediction of electrical properties should be possible. The difficulty here, and indeed throughout the theory, in arriving at numerical results lies in the fact that while the average distorting—*i.e.* expanding or contracting effect of dissolved atoms on a lattice—can be measured with considerable ease and accuracy by the aid of X-ray spectrometry, the maximum local distortion cannot as yet be determined directly. When this difficulty has been overcome, considerable further progress should become possible.

We may now briefly consider inter-metallic compounds. These are known to metallurgists from the occurrence of certain kinds of singular points on equilibrium diagrams and from characteristic features of micro-structure and of physical properties, but there are a number of alloys in which the existence of definite compounds has hitherto been regarded as doubtful. Again, the results of X-ray analysis, combined with the indications of the above theory, prove helpful. Very typical of inter-metallic compounds is the body $CuAl_2$ found in copper-aluminium alloys. It is a hard, brittle body, tending to crystallise in well-formed long needles. Its atomic structure has been determined by Dr. Owen and Mr. Preston at the National Physical Laboratory. The lattice-structure is shown in the accompanying diagram (Fig. 1). The most striking feature is that certain pairs of aluminium atoms approach one another within a range, centre to centre, of only 2·42 Ångström units. In an aluminium crystal the lattice-constant is 4·85 Å and the closest approach is 2·86 Å, and it would be quite impossible, by the application of external pressure, for example, to force the atoms so closely together as they are placed in the compound. The inference, which is justified by comparison with the known lattice structures of other chemical compounds, is that the very much closer approach of atoms in this manner is a characteristic, if not *the* characteristic, feature of chemical combination as distinct from the "cohesion bonding" which occurs in the building up of a crystal. It would seem, in the present case, that the copper atom which is combined with the two aluminium atoms has taken away or absorbed something from the aluminium atoms which now allows them to come much closer together. This may well be the absorption of certain exterior electrons by the copper atom; whatever the detailed mechanism may be, it is probably the essence of chemical combination, and furnishes us at once with a definite criterion for distinguishing between solid solutions and compounds. At first sight one might perhaps expect that intermediate classes of structure should be found, in which the inter-atomic distances might be only slightly less than in the typical solid solutions. If our current views of the structure of the atom in "shells" or layers of electrons is correct, however, this should not be the case; we should find either substances in which there is nothing more than "cohesion bonding" without closer approach of the atoms, or bodies in which the atoms are drawn closer by a definite step.

There is a further distinction which can be inferred from the present theory. In a body of the solid solution type, atoms of one kind are readily replaceable by atoms of the other; in a compound, on the other hand, it would be difficult to conceive of any atom being replaced by an atom of the other constituent. In the $CuAl_2$ structure, for example, it is scarcely possible that any of the aluminium atoms could be replaced by a copper atom. This very definite inference is verified by reference to the equilibrium diagrams of alloy systems in which typical well-defined compounds are to be found—these bodies never exhibit any appreciable amount of dissolving power for their constituents. If we may extend this view to those cases which, metallurgically, are still regarded as doubtful, it will at once serve to classify them into compounds and solid solutions respectively. A well-known group of alloys of this kind is the copper-zinc alloys (brasses), which exhibit a series of solid solutions generally called the alpha, beta, and gamma phases. These are micrographically distinct, and vary widely in many of their properties, and it has been thought that each was based upon a definite chemical compound possessing a wide range of dissolving power for copper and zinc.

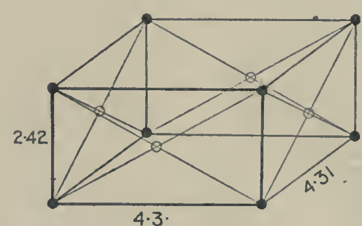


Fig. 1.—Lattice structure of $CuAl_2$.
● Cu. ○ Al.

In one of the papers mentioned above (May lecture) the writer suggested that these bodies need not be, and probably were not, based on definite compounds, but that they would probably be found to be based upon what might be termed allotrope lattices of copper. In the case of iron and nickel, for example, it is known

that the presence of a sufficient proportion of nickel will maintain the iron in the face-centred cubic lattice of the gamma phase at a temperature at which, in the absence of nickel, the iron would have reverted to the body-centred cube of the alpha phase. Presumably the iron remains in the gamma condition because in that condition it can retain a larger proportion of nickel atoms on the lattice, and because this arrangement involves less potential energy than any alternative. In the same way it was thought that the usual face-centred cubic lattice of copper might, when in the presence of more zinc atoms than can be carried on that lattice without undue distortion, be transformed into another lattice—still essentially a lattice of copper—but capable of carrying a larger number of zinc atoms, and that at a still higher concentration of zinc a further modification of the lattice might occur. Each successive modification would, in such a case, be expected to show an increasing approximation to the hexagonal lattice of zinc itself. Actual determinations of the lattices of the beta and gamma phases of the copper-zinc system, made by Owen and Preston in consequence of this suggestion, have completely verified it. The two phases show no compound lattice, but a modified copper lattice.

Another point of some interest in the distinction between solid solutions and compounds may be briefly considered. A good deal of consideration has been given by Tammann [2] to the chemical properties of solid solutions, Tammann's work being based on the idea of a substitution structure, but without reference to lattice distortion. If this principle is applied, however, an interesting conclusion may be drawn, to which attention was first directed by Mr. Preston, in regard to what may be termed "symmetrical" solid solutions. In any alloy system forming a continuous series of solid solutions between two metals, alloys must occur in which the two kinds of atoms are present in some simple ratio such as one to one, two to one, three to one, etc. According to the particular nature of the lattice system in each case, some of these simple ratios will allow the atoms to arrange themselves in a perfectly symmetrical manner. Such perfectly symmetrical atomic arrangement, however, is not likely to be attained or approached except in specially favourable circumstances. Very gradual cooling from fusion and a considerable rate of diffusion are essentials, but there is the further condition that the symmetrical arrangement in question should be a simple one. Thus in any lattice, an arrangement in which alternate layers or planes of atoms consist each exclusively of one kind of atom would seem to be such a simple arrangement. In the face-centred cubic lattice a one-to-one ratio allows of such an arrangement, all the atoms at the cube corners and those at the centres of two opposite faces being occupied by one kind of atom and the remaining four face-centres by the second kind of atom. In such a lattice, another simple symmetrical arrangement, but one less easily formed by the process of diffusion required by the present theory, is that in which all the face-centres are occupied by one kind of atom and all the cube corners by the other, this implying an atomic ratio of three to one.

The special interest which attaches to such perfectly symmetrical arrangements is that, if fully attained, there will be in such a lattice a perfectly uniform atomic spacing. The consequence must be, if the present theory is correct, a single melting-point and relatively low hardness and electrical resistivity. In some alloy systems, this state of affairs is so closely approached that it becomes plainly visible on the equilibrium diagram as experimentally determined, and the presence of a compound at the simple atomic ratio in question has sometimes been inferred—wrongly, according to the present view. In other systems, where diffusion is slow and uniform geometrical arrangement, therefore, is practically unattainable, the ideal condition is never reached experimentally, but the "solidus" curve shows an inflexion towards the "liquidus" in the neighbourhood of the "symmetrical" composition—in several examples near the one-to-one ratio of atomic concentration. In some alloy systems two such inflexions, corresponding approximately to two such ratios, have been observed. Although these inflexions have become increasingly definite in the best-determined diagrams, so that they could not be ascribed to experimental error, no explanation has as yet been offered. The fact that these details are only to be seen clearly in recent diagrams, prepared by methods of extremely slow cooling of the alloys, tallies well with the requirements of our theory.

Inferences from the substitution and lattice-distortion theory could be pursued at much greater length; so far, no failure of such an inference, when tested by means either of older well-established fact or by special experiments, has yet been found. There is thus some hope that a small but real step has been taken towards the better understanding of the nature of alloys, and particularly of solid solutions and intermetallic compounds.

[2] Tammann, *Zeitschr. f. Anorg. u. Allgem. Chemie*, July 1919.

Weather Influences in the British Isles.

By C. E. P. Brooks.

THE sun is the only source of terrestrial weather in the sense that the difference between the amount of solar radiation received in different latitudes is the driving force of the atmospheric circulation. The complexity of the earth's surface combined with its rotation about an axis introduces corresponding complexities into this circulation, but H. H. Clayton considers that "if there were no variation in solar radiation the atmospheric motions would establish a stable system with exchanges of air between equator and pole and between ocean and land, in which the only variations would be daily and annual changes set in operation by the relative motions of earth and sun; the existing changes we call weather have their origin chiefly, if not entirely, in the variation of solar radiation." It has been found that some parts of the

earth, especially the tropics, respond readily to these solar variations, while in other parts the solar variation is almost completely masked by secondary modifications. Hence we may classify weather influences into two classes: solar, in which the influence of solar variation is directly recognisable, and terrestrial, depending on causes which at first sight are entirely due to the influence of the land, sea, or atmosphere. These two classes shade into each other, with no definite line between them.

The weather of the British Isles, apart from seasonal temperature changes, is almost entirely terrestrial in its control, being dependent on the distribution of pressure over the North Atlantic and Arctic Oceans and the continent of Europe. This distribution is constantly changing, and we experience a succession of "depressions" and "highs" which pass across or near these islands, bringing our notoriously variable weather. Careful examination of a series of daily weather charts shows, however, that the most rapid changes are generally only in details, the main features of the pressure distribution changing comparatively slowly, and four main types of weather have long been recognised. These are named after the cardinal points whence blow the winds characteristic of the type—southerly, westerly, northerly, and easterly.

In the southerly type, pressure is high over Europe and low over the North Atlantic. Depressions are continually appearing over the ocean, but their centres fail to reach the British Isles, so that we are situated between a depression to the west and an anticyclone to the east, a condition which brings southerly winds and warm weather. The amount of rainfall depends on whether the high or the low pressure predominates over the British Isles; it decreases from west to east. In the westerly type, pressure is high in the south and low in the north, and depressions appear from the Atlantic and pass rapidly eastward, generally along a track somewhat to the north of Scotland. This type brings fresh westerly winds; spells of a day or two of very fine weather alternate with spells with more or less rain, the actual amount being least when the storm tracks lie farthest north. If in addition to high pressure to the south an anticyclone develops over Iceland, with a trough of low pressure between, the depressions pass directly across the British Isles and very rainy weather is experienced, sometimes with destructive gales. On the other hand, when the southern anticyclone extends so far north as to include Great Britain, very fine weather is experienced, which, if prolonged, as in 1921, may give rise to a serious drought. A moderate development of the westerly type forms about seventy per cent. of our weather.

The northerly and easterly types are more or less reversals of the southerly and westerly types; the easterly type proverbially brings us our most unpleasant weather. These weather types may persist for periods varying from a few days to weeks, and unfortunately there is generally little means of knowing, when a type first becomes established, how long it is likely to continue. Some cases are more favourable, notably the formation of a large anticyclone centred directly over the British Isles. In such a case a long spell of fair weather is very probable, and when this distribution was established on September 26, 1921, a long-range forecast of fair weather for the next fortnight over eastern and central England was issued by the Meteorological Office, and was justified by results. The original division of weather into four types has been extended by the critical analysis of long series of daily weather charts, the most recent classification being that made by E. Gold,[1] and much material is now available for statistical study.

An understanding of British weather depends on an understanding of the causes which lead to the establishment and modification of weather types. We may carry the study a step further by referring to the conflict between "polar" and "equatorial" air, envisaged by the Norwegian meteorologists in their researches on cyclones; but a better insight into ultimate causes is given by the older conception of "centres of action," according to which the dominant factors in the pressure distribution are three: the area of low pressure which is generally found in the neighbourhood of Iceland or southern Greenland, and is termed the Icelandic minimum; the area of high pressure which occupies the eastern Atlantic near and south of the Azores, termed the Azores anticyclone; and in winter, the area of high pressure which is centred in Siberia and extends in a west-south-westerly direction towards the Azores anticyclone.

If we could forecast the position and intensity of these three centres of action during any month, we should be well on the road to true long-range weather forecasting. That is not yet the case, but a certain amount of information has been gleaned which encourages further research. The Siberian winter anticyclone appears definitely to be due to the extreme "continentality" with its low temperatures and hindrance to the outflow of air; it is, in fact, a "pool" of cold air. Such a continental anticyclone itself intensifies the cold of winter, and once formed is difficult to dislodge. There is nothing more favourable to the establishment of anticyclonic conditions than a covering of snow, and an extensive snowfall over northern or eastern Europe early in the winter may cause a persistent westerly extension of the Siberian anticyclone, influencing the weather of the British Isles for several months.

The other two centres of action are still more important, and they are intimately connected with each other. When pressure is high at the Azores it is generally low near Iceland, and vice versa; when the Azores anticyclone advances northward the Icelandic minimum generally does likewise, but there are exceptions to both these rules. There have been cases, notably February 1895, when the distinction between the anticyclone and the depression was wiped out, and for a whole month pressure was higher at Iceland than at the Azores. The existence of these two centres of action is connected in some way, not yet fully understood, with the general circulation of the atmosphere, but there can be no question that the details of their position and intensity are modified by local effects, and especially by variations of sea temperature, and in the case of the Icelandic minimum by the presence or absence of floating ice, and we

[1] London, Air Ministry, Meteorological Office. Geophysical Memoirs, No. 16. Aids to forecasting: types of pressure distribution, with notes and tables for the fourteen years, 1905–1918. By E. Gold. London, 1920.

have to broaden our survey to include these two factors.

The primary facts about the circulation of the waters of the North Atlantic Ocean are familiar to most people, and for our purpose can be generalised into two processes. First, a great mass of warm surface water is driven westwards near the equator by the Trade winds, ultimately being deflected northward by the coast of America and forming the Gulf Stream; secondly, this warm water is spread out south-east of Newfoundland, and is driven eastward by the prevailing winds towards the European coast. Consequently, any increase in the strength of the Trade winds should be followed after a considerable interval by a rise in the temperature of the sea north of Scotland. This has very little direct influence on the temperature of these islands, but it intensifies the Icelandic minimum and draws it south-eastward, causing low pressure and much cyclonic activity in the North Sea, with strong south-westerly winds over Holland, Germany, and Denmark, and northerly winds over Iceland. Thus, P. H. Gallé[2] found that when ships' observations showed an increased strength of the Trades during spring and summer, the following winter was warm over Holland and Germany, but cold over Iceland and Greenland. This refers to observations over the whole Trade belt. Unfortunately, direct observations of the strength of the North-east Trade are difficult to obtain, but we may employ instead the mean pressure at the Azores, which may be taken as a measure of the development of the North Atlantic anticyclone, with which the Trade wind is associated. The interval between the occurrence of high pressure at the Azores and of low pressure near the Faroes is about a year, which is the average time required for the completion of the oceanic circulation between these points.

The influence of floating ice on the pressure distribution is equally marked. The great ice-factory of the northern hemisphere is the Arctic Ocean north of the Eurasian coast, and delivery is effected by a current which sets from near Spitsbergen down the east coast of Greenland and round Cape Farewell. Each spring this current carries great masses of sea-ice, and in some years with strong north-westerly winds much of this ice is carried to the coasts of Iceland. From 1901 to 1919 there were 43 months during which ice lay off Iceland for more than five consecutive days, and in the majority of these months pressure in Iceland was more than 2 mb. above normal. The mean deviation of pressure from normal during the whole of the ice-days (to the number of 701) was +6·7 mb. Since there is no reason to suppose that the high pressure brings the ice, this result indicates conclusively that the ice and the cold surface water associated with it are effective in raising the pressure over Iceland and producing a northerly type of weather in the British Islands.

W. Weise[3] has recently made a further step. The ice takes about 4½ years to travel from the Arctic Ocean north of Siberia, where it is formed, to the East Greenland current, and he found that low temperature at Obdorsk and Turuchansk in autumn is followed after this interval by a large amount of ice east of Greenland, and vice versa. Thus an important factor in our spring weather is determined by conditions 4½ years previously in the north of Siberia.

The influences which control British weather are many and diverse, and it is not wonderful that the small fluctuations of the solar constant elicit no obvious response. Yet they can sometimes be traced; for example, at times of increased solar radiation (and many sunspots) the tracks of depressions appear to be on the average rather further south than with diminished radiation (and few sunspots). From 2 to 4½ years after sunspot maxima the Azores anticyclone tends to spread northward in summer over Spain and the Bay of Biscay, or even over the British Isles, giving conditions favourable to drought. Various other solar effects have been suggested in British weather, but none are definite enough for use in forecasting. The same conclusion must apply to "weather cycles." The search for the golden cycle in weather is curiously similar in its history to the search for the philosopher's stone—it has not been found, and we are more and more compelled to the belief that it does not exist; but in the search for it much information of value in other respects has been acquired. Periodicities in weather there undoubtedly are, but they are usually either so small in amplitude as to be of academic interest only, or they show baffling changes of phase and amplitude. Even the classical "Brückner cycle" of 35 years is only recognisable when we add the rainfall of ten consecutive years together, and its absolute uselessness for forecasting is shown by the position of the dry year 1921—one year before a maximum. The standard deviation from normal of a month's rainfall in London is about sixty per cent., while the variation attributable to the Brückner cycle is less than three per cent. A similar criticism applies to Sir William Beveridge's periodicities in the price of wheat.

Ocean currents and floating ice are thus the most important factors in British weather. Given a foresight of these two elements, we could make a reasonable guess at the general type of weather likely to prevail, though not the changes from day to day. Both ocean currents and ice are themselves also subject to modification by pressure distribution, and consequently we have a chain of cause and effect connecting a succession of months or seasons. We know the normal oceanic circulation and the normal pressure distribution. If in a given month we knew also the deviation of pressure from the normal distribution, we should be able to infer the abnormalities which will be produced in the oceanic circulation and hence to calculate the pressure deviations for the following month. If the process were sufficiently well understood we could carry our calculations forward long enough to give useful forecasts; at present the subject has scarcely reached even the experimental stage. A large statistical basis is necessary, and it is only within the last few years that this has begun to be supplied by the *Réseau Mondial*,[4] a compilation of monthly means of pressure, temperature, and rainfall over the globe.

[2] On the relation between fluctuations in the strength of the Trade winds of the North Atlantic Ocean in summer and departures from the normal of the winter temperatures in Europe. Amsterdam, Proc. R. Akad. Wetenschap, vol. 18, No. 9.

[3] Die Einwirkung des Polareises im Grönländischen Meere auf die nordatlantische zyklonale Tätigkeit. Berlin, *Ann. Hydrogr.*, vol. 50, 1922, p. 271.

[4] London, Meteorological Office, British Meteorological and Magnetic Year-Book, Part V. 1910–1914 issued.

Obituary.

MR. T. PRIDGIN TEALE, F.R.S.

In the death on November 13, at the age of eighty-two, of Mr. T. Pridgin Teale, medicine and sanitary science have lost a leader, and society has lost a very interesting man. For some generations the Teales had been medical practitioners in Leeds, and Mr. Pridgin Teale's father—of the same name—had likewise a very large consulting practice in surgery in and beyond the county of Yorkshire. The family were in part of Huguenot descent (Pridgin = Prujean), and to this strain no doubt Pridgin Teale owed much of his social charm and vivacity.

Of Pridgin Teale's eminence as a surgeon there is no need to speak; for the particulars of his professional work our readers will look to the medical journals; it is our place to speak of his work as a man of science, and especially as a reformer in sanitary practice and in economy of fuel. For twenty years he was president of the North-Eastern Branch of the Sanitary Inspectors' Association, and to that body he delivered many addresses full of that vigour and acute practical intelligence so characteristic of him. He was as ardent in teaching and persuasion as he was ingenious in suggestion and contrivance. In his well-known fire-grate constructions it is interesting to know that Mr. Teale was in intimate association, on the æsthetic side, with Mr. de Morgan. Since the days of Mr. Teale's most active life many changes have passed over sanitary science, but among the earnest and inventive pioneers in these subjects, Pridgin Teale's name will scarcely be forgotten.

To his friends Pridgin Teale was one of the most attractive of men. Absolutely sincere, unselfish, blithe, and enthusiastic, he was one of the most charming of companions and the most loyal and generous of friends.

C. A.

BRIGADIER-GENERAL G. E. PEREIRA.

The death, at the age of fifty-eight, of Brigadier-General G. E. Pereira is a severe loss to Asiatic geography, owing to the wide range of his Chinese travels. He served at home in the Grenadier Guards until 1899, when he was sent on special service to China and was attached to the Chinese regiment in the British Protectorate of Wei-hai-Wei. He accompanied the Japanese army in Manchuria in 1904, and was military attaché at Peking from 1905–10.

General Pereira made good use of the intimate knowledge of the Chinese and fluent mastery of the language acquired during these services, in long journeys in China and Chinese Turkestan. His best known expedition was his walk overland in 1921 from Peking to India across Tibet and through Lhasa. In this journey he obtained much valuable information, especially accurate heights of some of the passes in eastern Tibet. In 1922 he started on what was intended to be his last expedition, and crossed from Bhamo in Burma by the chief road through south-western China to the Yangtze at Sui-fu. He descended the Yangtze by boat, and visited the island of Hainan in connexion with his ethnographic studies. He returned up the Yangtze to Yunnan-fu, whence in company with Dr. Thompson he set out for south-eastern Tibet in the hope of reaching Amnemachin, which is thought to be the highest peak in the Kwen-lun Mountains, near the upper bend of the Hwang Ho. He had seen this mountain in 1921, and his descriptions led to the report that it might be the highest mountain in the world. Considering, however, its geographical relations, General Pereira's own estimate of 25,000 ft. is probably more correct. The two travellers reached A-tun-tze last August, and letters from Pereira were full of enthusiasm and hope for a successful journey to the Kuen-Luns. He reached Yakalo, the French mission station, well known as the residence of the Abbé Desgodins, by the Salt Mines on the Mekong. His last letters were dated there on September 15, and his fatal illness was probably on the borders of autonomous Tibet.

General Pereira had published but little, and those interested in Chinese geography hoped that he would devote his leisure to a general account of his extensive travels. He was an enthusiastic adherent of the traditional view that the Himalaya end in Assam, and some of his last letters from A-tun-tze re-stated his views on that problem. Amongst his scientific contributions was obtaining for the Natural History Museum its second Chinese skin of the Panda, one of those interesting animals living in southern China the affinities of which are American.

MR. W. H. DUDLEY LE SOUËF.

The October issue of the *Victorian Naturalist* contains an appreciation of the life and work of Mr. W. H. Dudley Le Souëf, Director of the Melbourne Zoological Gardens, who died on September 6, at the age of sixty-six. Mr. Le Souëf was a prominent member of the Field Naturalists' Club of Victoria, and his extensive travels over the Australian continent studying the habits of or collecting native animals, birds, etc., provided material for numerous papers which he contributed to the Club. In most of these the main interest centred on the birds, but other branches of natural history were not neglected. He compiled a list of Victorian reptiles published in the *Victorian Naturalist* of 1884, and was the author, with Mr. A. H. S. Lucas, of two standard works, "The Animals of Australia," and "The Birds of Australia." In another volume, "Wild Life in Australia," he brought together the accounts of his many expeditions which had appeared from time to time in the *Victorian Naturalist* and the *Emu*, the organ of the Australasian Ornithologists' Union, of which he was one of the founders. His interest in Australian ethnology led him to take part also in expeditions to King Island, the Kent Group, and to Albatross Island. Mr. Le Souëf was an enthusiastic student of Nature, who was always willing to bring natural history before an audience, generally illustrating his lectures by lantern slides from his own photographs. For many years he was Assistant Director of the Melbourne Zoological Gardens, and in 1902 he was made Director, in succession to his father. Under his care the Gardens have become the most important collection oi animals in Australia.

Current Topics and Events.

The satisfaction that has been expressed with the recommendation that the Imperial Institute should be maintained at South Kensington is accompanied with a still wider regret that the collections are to be abolished to make room for the War Museum. The Committee which has made these recommendations appears to regard the collections as of use only as trade samples and accepts the view that those at the offices of the Australian agencies in the Strand are more useful. The Imperial Institute collections, however, are much wider in their scope. The Imperial Conference urged the need of extended teaching of the geography of the Empire, and the Imperial Institute collections are unique as an illustration of the life, resources, and scenery of every country within the Empire. It is the only collection in Great Britain which can be compared with the geographical museums of Germany. The Institute is naturally of less value to the great Dominions, which can afford well-equipped research departments and show rooms in the centre of London, than it is to the smaller colonies and dependencies. Hence Australia in pre-War times contributed to the Institute only 500*l*. per annum against 1000*l*. given by Ceylon. The smaller dependencies, and especially those in the tropics, are in increasing need of the help that may be given by an Imperial co-operative organisation. Emphatic testimony to the educational value of the galleries is quoted in the minority report, in which New Zealand offers an increased subsidy if they be maintained. The collections are also condemned on the ground that they are only of value to people in London, a drawback shared by all national metropolitan institutions. The leasing of the galleries is recommended as a means of raising 8000*l*. per annum for the general revenues of the Institute. For this amount costly collections made and presented by governments and individuals are to be scrapped, and a building largely raised by private subscriptions, and the site given by the Commissioners of the 1851 Exhibition for an Imperial scientific institution, are to be handed over to a War Museum. Mr. H. M. Lidderdale, Secretary to the executive council, has been appointed Acting Director pending the re-organisation of the Institute.

The *Times* in its issue for November 28 publishes a very interesting photograph showing the eggs of a deinosaur against their natural background; in fact, they can scarcely be said to have been removed from the beds in which they were so happily preserved. The discovery, made by Mr. Roy Chapman Andrews when exploring a desert region in Mongolia for the American Museum of Natural History, has excited much interest among naturalists, and it is now authoritatively announced that surplus specimens, after complete examination and description, will be disposed of for about 400*l*. apiece. This price cannot be regarded as excessive, and the sum realised will be used towards defraying the expenses of the expedition. When placed on exhibition in a public museum, the egg should certainly be accompanied by a copy of the photograph utilised by the *Times*, showing its companions practically *in situ*. By that time, the scientific report on the occurrence will be available, and will no doubt contain all necessary illustrative material. The relationship of the deinosauria to the crocodiles and to the birds makes the discovery of their eggs not in itself surprising; but the fact that one egg at least contains an embryo furnishes hope for the revelation of new links in the chain of reptilian descent. Public interest should now be still further attracted to the fine collection of deinosaurian remains in the Natural History galleries of the British Museum at South Kensington, and to the admirable guide recently issued in connexion with them (see NATURE, April 29, 1922, p. 561). We can already conceive a wall-painting in the American Museum of Natural History, depicting the Gobi region in Mesozoic times, with a maternal deinosaur affectionately bringing up its young.

Among the scientific bequests of the late Hon. N. C. Rothschild, whose death was referred to in NATURE of November 10, p. 697, those relating to the distinguished naturalist's great collection of Siphonaptera, or fleas, are of special interest not only to entomologists, but also to students of insect-borne disease. Including as it does some 40,000 specimens of fleas in alcohol, and 3550 microscope slides, representing in all about 600 species, the collection must prove of priceless value to all who in future years desire to investigate questions connected with the epidemiology of bubonic plague, and its transmission by various species of fleas. Although actually presented to the Trustees of the British Museum in 1913, the collection was, by arrangement, allowed to remain temporarily in the possession of its founder; and even now a further period will elapse before the specimens, which occupy eight large cabinets, are finally installed at South Kensington. During the interval, the catalogue of the collection, which will include an illustrated description of every species represented in it, will be completed by Dr. K. Jordan, the value of whose work on Siphonaptera, as collaborator with the late Mr. Rothschild, has obtained world-wide recognition. To provide for the permanent maintenance of the collection, Mr. Rothschild has left to the Trustees of the British Museum 10,000*l*. upon trust, in order that the income thereof may be utilised to pay the salary of a qualified custodian. In the testator's will, the request is made that Mr. F. J. Cox, his assistant, should be employed in the latter capacity. Mr. Cox is known to possess a wide knowledge of Siphonaptera, and it was by him that, at the instance and expense of Mr. Rothschild, the small collection of fleas already belonging to the Museum was catalogued and arranged some years ago.

It is rumoured, but we hope without foundation, that a suggestion has been made to the Albanian Government that exclusive rights of excavating in Albania should be assigned to French archæologists, with possession of a considerable proportion of the finds. Although no one would wish to question the

right of the Albanian Government to make such arrangements as it thinks best for the investigation and preservation of the antiquities of that country, such a course as is proposed cannot, on the face of it, be considered in the best interests of science. It is not intended to cast any reflection upon the ability or disinterestedness of the archæologists of France or any other country; but scientific investigation should be free from the trammels of nationality. The position in the Balkans is already one of some difficulty, as recent legislation in Greece has restricted the number of excavations which will be permitted to the Schools of Archæology beyond those already in being, while in Serbia concessions for excavation are not to be granted at all to foreigners. In view of the great importance of the whole Balkan area for archæological studies, any further restriction, such as this proposal to confine excavation in Albania to scientific workers of one nationality only, would be peculiarly unfortunate.

A NECESSARY consequence of any increased interest in, and consideration of, science and scientific workers by the general public will be an examination of the part that science has played in producing the bad, as well as the good, features of modern civilisation. It is natural that the advance of science in penetrating the mysteries of the universe, or its essential part in promoting the development of material resources and making possible mechanical production of commodities necessary for peace or war, should be a satisfactory subject of contemplation to the scientific worker. But the public will not only ask about the responsibility of men of science for the development of fertilisers or of poison gases, but also what they think is the relation between the present possible level of productivity and the present destitution in every civilised state. Prof. F. Soddy anticipated such questions as these in his "Cartesian Economics" lectures, and he developed them in a lecture entitled "The Inversion of Science," given at the Guild House, Eccleston Square, on Thursday, November 29. He pointed out the strange coincidence of the perfection by James Watt in 1774 of the steam engine which was to revolutionise all the methods and possibilities of production, and the elaboration in 1776 by Adam Smith in "The Wealth of Nations" of a system of economics founded on the conditions prevailing in the pre-scientific stage of society, which has nevertheless continued to be applied, with the result of an almost unlimited capacity for production that cannot be exercised because of a completely erroneous standard of values. Prof. Soddy held that wealth must cease to be reckoned by any artificial standard, whether of gold or of the arbitrary judgment of financial magnates, and be calculated on the actual or potential production of the necessities of life.

DURING the War many unsuccessful experiments were tried to bring to a stop from a distance motor cars or aeroplanes. According to an announcement in *La Liberté*, a French engineer has given practical proof of an invention that enables him to stop the motors of an aeroplane or a motor car at a distance of about 50 yards. It is quite possible that the emission of very strong Hertzian waves might interrupt the proper functioning of magnetos at this distance, but we cannot infer that it would be equally simple to stop the motor of an aeroplane in full flight at a distance of a few miles. In any event the problem of protecting the magnetos of the motors from interference by suitably screening them would be an easy one.

THE transmission of a broadcast programme across the Atlantic by the British Broadcasting Company in the early hours of November 26 was a fairly successful one. From 3 to 3.45 A.M. the B.B.C. sent out a concert from London on its normal wave length and power. This was broadcasted again simultaneously by the other British stations, each on its own wave length. All the stations, with the exception of Birmingham, Manchester, and Aberdeen, were clearly heard in America. During the winter months transatlantic telephony and broadcasting is generally successful during night-time. During the early hours of November 27, American stations broadcasted. Several of them were heard in different places in Great Britain, but the atmospherics unfortunately were very much in evidence and so the experiments could not be regarded as successful. On December 22 the Radio Society of Great Britain will make experiments, in conjunction with American amateurs, between 1 and 3 A.M. The G.P.O. has given permission to some amateur stations to increase their normal power (10 watts) to 1000 watts for these tests.

WE regret to note an announcement in the December issue of *Discovery* that this number is to be the last to appear. All who are interested in the spread of a knowledge and appreciation of the results of scientific investigation among the general public will regret the disappearance of this publication. Since it was founded in 1920, *Discovery* has consistently maintained a high standard of scientific accuracy, and has placed before its readers in clear and non-technical language a large number of articles, necessarily varying considerably in merit, which were selected with the express intention of keeping readers abreast of the latest movements of thought in the scientific world. It was started under favourable auspices at a time when the events of the War had impressed upon the public mind the value of scientific research from a practical point of view. Its committee of management consisted of representatives of the most important of the scientific and learned societies, and amongst its contributors it has numbered some of the most prominent of the scientific men of the day. Yet notwithstanding these facts, and notwithstanding a wide appreciation of its merits as a popular scientific publication, it has failed through lack of public support.

IT was stated in our issue of December 1, p. 803, that the Science Collections from the Western Galleries of the Science Museum, South Kensington, had been removed to three unfinished galleries of the new Science Museum building, and that one of these galleries has now been thrown open to the

public. In this are the following exhibits: *Astronomy*: Sundials, astrolabes, and similar instruments, transit instruments, equatorials, astronomical photographs, telescopes, original apparatus and instruments made or used by the Herschels. *Surveying*: Instruments illustrating the development of the theodolite and level, including Ramsden's three-feet theodolite. *Meteorology*: Almost the whole section as previously exhibited, with a recent acquisition—a plaster cast of an early Korean rain-gauge. *Chemistry*: Historical apparatus and specimens, including apparatus of Faraday and Graham; Hartley's original spectrograph; replica of Priestley's original oxygen apparatus; models of chemical works. *Optics*: Microscopes, telescopes, spectacles, polariscopes, early moving-picture devices. *Sound*: Early talking machines, including Edison's original phonograph; instruments used in sound-ranging. *Botany*: Models of flowers. About eighty per cent. of the Science Collections will be in storage until more space becomes available.

IT is announced in the *Times* that 13,000,000 francs (more than 160,000*l.*) was collected for the benefit of French scientific laboratories on the occasion of "Pasteur Day."

DR. F. W. WILLWAY, J.P., Newfoundland, provides an interesting running comment on the film production "Nanook of the North" at the Polytechnic Hall, London. His talk, based upon personal experience, takes the place of the customary captions and makes more real this untouched and unrehearsed picture story of the actual life of the Eskimos on the west side of Ungava. The musical accompaniment to the closing scene, an Arctic blizzard, enhances the effect so strongly that the impression of desolate brutality lasts long after the vision ceases. Mr. Flaherty's picture is assuredly one to see.

RECENT additions to the National Portrait Gallery include the portraits of three former fellows of the Royal Society, namely:—Sir George Howard Darwin, K.C.B. (1845-1912); Sir Henry Charles Englefield, Bt. (1752–1822); and Mr. Philip Metcalfe (1735–1818).

THE Huxley medal of the Royal Anthropological Institute for the year 1923 has been awarded by the Council to Dr. E. Sidney Hartland, the well-known authority on folklore and the author of "Primitive Paternity" and other pioneer works on social anthropology. Unfortunately, the state of Dr. Hartland's health in the earlier part of the year has precluded him from preparing the Huxley memorial lecture, which it is usual for the recipient to deliver on the occasion of the presentation of the medal. The Huxley medal for the year 1924 has been awarded to Dr. Henri Verneau, of Paris, by whom the Huxley memorial lecture for 1924 will be delivered in November next.

MR. JOSEPH BARCROFT has been elected Fullerian professor of physiology at the Royal Institution in succession to Sir Arthur Keith. M. le Duc de Broglie, Dr. C. L. Guillaume, and Profs. Debye, Einstein, Groth and von Laue have been elected honorary members of the Institution.

THE British and Foreign Sailors' Society, Incorporated, The Passmore Edwards Sailors' Palace, 680 Commercial Road, London, E14, supplies Christmas parcels regularly to more than 600 lighthouses and lightships; in addition it maintains 650 ships' libraries afloat, and parcels of literature and magazines are regularly placed by the Society on outgoing ships. Gifts of literature, books, magazines, etc., would be welcomed at the Society's headquarters.

THE following officers and committee of the University of Durham Philosophical Society for the Session 1923–24 have been elected: *President*: Rt. Hon. Earl of Durham; *Vice-Presidents*: Hon. Sir Chas. A. Parsons, Sir Theo. Morison, Dr. T. H. Havelock, Dr. H. Stroud, Prof. H. Louis, and Mr. W. Hall; *Committee*: Commander C. J. Hawkes, Dr. H. V. A. Briscoe, Dr. G. R. Goldsbrough, Dr. J. A. Smythe, Mr. S. H. Collins, and Mr. Rhys Thomas; *Editor*: Dr. G. W. Todd; *Librarian*: Dr. F. Bradshaw; *Secretaries*: Mr. J. W. Bullerwell and Mr. B. Millard Griffiths. The second edition of the "Dr. Theodore Merz" Memorial Number of the Proceedings is now in the Press.

AT a meeting held in June last, it was decided to establish a memorial to the late Prof. A. D. Waller and Mrs. Waller in the form of a fund for scientific research to be administered by the Council of the London (Royal Free Hospital) School of Medicine for Women (NATURE, June 16, p. 818). Prof. Waller was also lecturer in physiology at St. Mary's Hospital Medical School for nineteen years, and it is now proposed to establish an additional memorial in the form of a research room, to be known as the Waller Research Laboratory, in connexion with the Physiological Department. A large and distinguished committee of British and foreign scientific workers has been formed to carry out the memorial schemes. Subscriptions marked accordingly if they are intended for the St. Mary's Hospital Medical School memorial, should be sent to the hon. treasurer of the fund, Prof. J. Mellanby, St. Thomas's Hospital Medical School, London, S.E.1.

MR. W. H. HOFFERT has been appointed by the Council of the University of Leeds to be research chemist to the Joint Research Committee of the National Benzole Association and the University in succession to Prof. E. C. Williams, who resigned his appointment on September 30, on his election to the Ramsay memorial chair of chemical engineering in the University of London. Mr. Hoffert took a first class at Oxford in 1914, in the final honour school of natural science (chemistry), and was also awarded a research scholarship at Jesus College. In 1919 he was appointed to a research fellowship of the Salters' Institute of industrial chemistry. More recently, he has worked as research chemist to a Lancashire firm engaged in the coal tar industry, and has also had experience at H. M. Fuel Research Station, Greenwich. Mr. Hoffert will work in the Department of Coal Gas and Fuel Industries of the University of Leeds, under the supervision of Prof. J. W. Cobb, particularly in connexion with the possibilities of increasing the home supplies of motor spirit from coal.

Prof. A. Smithells resigned in June last the chair of chemistry in the University of Leeds, which he had held with much distinction since, in 1886, he was appointed in the old Yorkshire College. His part in promoting the foundation of the University of Leeds, in bringing technological studies into relation with other work of the University, in furthering chemistry and its technical applications, and in linking up the University with the community it serves, is well worthy of commemoration, and a committee has been appointed to raise funds for this purpose. With the money obtained it is proposed to have a portrait of Prof. Smithells painted for presentation to the University, and to establish in his name, and by his advice, a fellowship or scholarship within the University—two means by which his connexion with the University will be handed down to posterity. Subscriptions, made payable to the treasurer of the Smithells Fund, should be forwarded to Mr. A. G. Lupton, Beechwood, Roundhay, Leeds.

Mr. Paul C. Standley, associate curator of plants in the National Museum, Smithsonian Institution, has left Washington for Panama, where he will make investigations of the plant life of the Canal zone and its immediate vicinity. This work, undertaken in co-operation with the Department of Agriculture, has for its object the preparation of a descriptive and illustrated account of the plants occurring in the region. Botanical exploration of the Isthmus of Panama was begun about 1790 by Luis Née, a Frenchman, who accompanied the famous navigator Malaspina on his voyage around the world. A very extensive collection also was obtained by the Smithsonian Biological Survey of the Panama Canal Zone in 1910–11, and more recent collectors have forwarded to the National Museum noteworthy collections, so that at the present time more than 2000 species of plants are known from the region. From a botanical point of view the Isthmus has not been thoroughly explored, however, and it is probable that further work there will increase this number by 50 per cent. Panama is particularly rich in palms, and has a good representation of orchids and ferns. After spending about two months in Panama, Mr. Standley will go to Costa Rica to make further collections of plants.

In the course of his presidential address to the Institution of Civil Engineers delivered on November 6, Sir Charles Langbridge Morgan had a good deal to say in encouragement of the numerous young men seeking to enter the civil engineering profession, often with an equipment of scientific knowledge and general education which would have been regarded as exceptional in his own early days. Sir Charles traced the development of transportation in Greater London during the past fifty years, and gave a number of interesting tables relating to local railways, suburban sections of main-line railways, tramways, omnibuses, etc.; these carried a total of 1,036,806,934 passengers in 1900 and 3,125,321,122 in 1920. From the developments which have taken place, and others projected, Sir Charles refuses to believe that the profession of civil engineering has entered upon a permanent decline. No one can deny that there is reason for temporary discouragement of young men who are at present confronted with extraordinary difficulty in obtaining work. If the older members were to shut their eyes to the seriousness of the position of junior members of the profession, they would be failing in their duty. It is the part of such bodies as the Institution of Civil Engineers to do all that can be done by organisation, encouragement, and co-operation to hasten that recovery of the whole profession to which all look forward.

A guide, with code and instructions, relative to wireless weather telegraphy in Great Britain and the countries of Europe and North Africa, has recently been issued by the Meteorological Office of the Air Ministry (M.O. 252, H.M.S.O. 2*s*. 6*d*. net). The details of the meteorological messages transmitted by the several countries are arranged on a uniform plan. Times of sending are explained and the meanings of the symbols used, so that any one having the suitable equipment can receive both reports and forecasts. The issue of particulars of the messages from different countries is brought up to date, and amending notices will be issued as required from time to time. Purchasers of this new edition of the guide will be informed when fresh notices are issued if they notify the Director of the Meteorological Office that they desire to receive the information. Use can be made of messages transmitted to the Meteorological Office by the aid of which the daily weather reports and forecasts are prepared for the Press and the general public. In addition to this a "general inference" is issued at 9.15 A.M. and 8 P.M. based on observations taken at numerous local and foreign stations as well as over the Atlantic. An example is given of the "general inference," and it is stated that "the first transmission of this report is made at ten words a minute for the benefit of amateurs." The message is in plain language, and can be readily understood by others than meteorologists. The general inference is in effect a picture in words from which a general survey of the prevailing and controlling weather conditions can be obtained.

The annual reports of the Smithsonian Institution of Washington contain not only full statements of the activities of the Institution during the year, but also a large general appendix which consists of a miscellaneous collection of memoirs covering a wide range of subjects. This appendix forms fully three-quarters of the volume for 1921, which has recently been issued, and it provides a valuable collection of noteworthy scientific papers issued during the year. Many of the items are original and by American workers, while others are translations and reprints. Among the latter are: "Cosmogeny and Stellar Evolution," by Mr. J. H. Jeans, from Nature of June 30 and July 7, 1921; and "The Age of the Earth," by Lord Raleigh, Prof. W. J. Sollas, Prof. J. W. Gregory, and Dr. Harold Jeffreys, from Nature of October 27, 1921. The translations included are: "The Diameters of the Stars," by A. Danjon, from *L'Astronomie* of November and December 1921; "The Historic

Development of the Evolutionary Idea," by Branislav Petronievics, which is a translation of the first chapter of Petronievics' work, "L'Évolution universelle"; "The Heredity of Acquired Characters," by Prof. L. Cuénot, from the *Revue Générale des Sciences* of October 15, 1921; "The Indian in Literature," by Herman F. C. ten Kate, from papers published in the Dutch magazines *De Gids* (1919) and *De West-Indische Gids* (1920); and "The Alimentary Education of Children," by Prof. Marcel Labbé, from the *Revue scientifique* of September 10, 1921.

THE Christmas lectures at the Royal Institution, which are to be delivered this year by Sir William Bragg, will be published afterwards in book form by Messrs. G. Bell and Sons, Ltd., under the title, "Concerning the Nature of Things."

WE have received from Messrs. Ogilvy and Co., 18 Bloomsbury Sq., W.C.1, the British agents, new editions of Leitz catalogues of microscopes and dissecting microscopes and magnifiers. Microscopes, objectives, magnifiers, and other apparatus of all types are listed, and the purchaser has a wide choice as regards both elaboration and price. In addition, some interesting and instructive details are given of the general properties of objectives and eyepieces and of their classification.

MESSRS. C. BAKER, of 244 High Holborn, London, W.C.1, have recently issued a new classified list of second-hand scientific instruments (No. 79) which they have for disposal. The catalogue contains a large assortment of apparatus, and particularly of microscopes, telescopes, and their accessories. Among the astronomical telescopes (refractors) are a 12 in. equatorial and a 7¼ in., both by Cooke, and an 8 in. by Grubb. A wireless department has been established by Messrs. Baker, and a list of the apparatus available, all of which is new, has been added to the catalogue of second-hand instruments.

IN the Year-book of the Royal Society of Tropical Medicine and Hygiene, Session 1923-24, recently issued, an account with illustrations is given of the Chalmers and Manson memorial medals of the Society. The former, founded by a donation from Mrs. Chalmers, is in memory of Dr. Albert J. Chalmers; the latter, by a surplus of a portrait fund, is in memory of Sir Patrick Manson. The Chalmers medal is awarded biennially, and this year has been presented to M. E. Roubaud, of the Pasteur Institute, Paris. The Manson medal is awarded triennially, and has been presented to Sir David Bruce.

THE Cambridge Philosophical Society is to publish, through the Cambridge University Press, as separate supplements to the Proceedings, translations of Dr. Niels Bohr's present series of papers "On the Application of the Quantum Theory to Atomic Structure," Part I. of which has already appeared in the *Zeitschrift für Physik*, vol. xiii. (1923). The translation of Part I. will be closely followed by a similar translation of Part II., which it is hoped will appear simultaneously with the German version. Part I. will deal with the fundamental postulates of the quantum theory, and Part II. with the theory of series spectra.

ERRATA.—In our issue of November 10, p. 704, in the Research Item on the Early Proboscideans, for "Schlasser" read "Schlosser"; December 1, p. 806, in the Research Item on the Cheiropterygium in Amphibia, line 3 from end, for "its first 'i'" read "its first 'e.'"

Our Astronomical Column.

THE DECEMBER METEOR SHOWER.—Mr. W. F. Denning writes: "This annual display of meteors may be expected on the night of Wednesday, December 12, when it will probably reach its maximum intensity. The shower is visible, though it supplies very few meteors, during the first week of December, and the radiant point appears to be a moving one like that of the August Perseids. As the moon will be absent from the evening sky during the early part of December this year, it will be possible to watch the oncoming and development of the shower if we get sufficiently clear weather. The position of the radiant on Dec. 1 will be about $98° + 34°$; on Dec. 5, $104° + 33°$; on Dec. 10, $110° + 33°$; and Dec. 15, $116° + 32°$.

"Occasionally, the shower proves a rich one and supplies about 40 or 50 meteors per hour; but the most abundant displays are usually witnessed in the morning hours, as the radiant is then at a greater altitude than in the earlier part of the night. In 1920, on Dec. 12, the shower returned with considerable strength, though it does not appear to have been well observed, in consequence of unfavourable weather.

"The individual meteors of this stream are moderately swift and short, and as they do not often leave streaks or trains they are rather difficult to record accurately. The radiant point is therefore not often determined as correctly as that of the Perseids or Leonids."

COMPANION TO OMICRON CETI.—The interesting variable Omicron or Mira Ceti has been found by Prof. R. G. Aitken (Harv. Coll. Obs. Bull. No. 792) to have a close companion, at distance 1·01″, position angle 132·3°. The companion was bluish in colour, and on October 19 was fully half a magnitude fainter than the variable. The tardy discovery of a companion to such a well-scrutinised star is remarkable, and suggests that the distance may be increasing. It will doubtless be carefully followed in the hope of obtaining an orbit, which would determine the mass of Mira. It is possible, however, that the pair is an optical, not a physical, double.

PROPOSED OBSERVATORY IN NEW ZEALAND.—The Bulletin of the New Zealand Astronomical Society announces that the University of Yale has offered a large telescope for astronomical observation in New Zealand, provided a good site can be found, the conditions of seeing to be tested with a telescope of 6 or 7 in. aperture, in a similar manner to the tests made before setting up the Victoria telescope in British Columbia. The New Zealand Government has been approached to grant funds for this examination, and has given a hopeful reply. The difficulty appears to be to combine good seeing with convenient access. Most of the towns are near the coast, and the seeing is poor. Various sites are suggested by amateur astronomers, and it is greatly to be hoped that the scheme may go through.

Research Items.

The Causal Organism of Braxy in Sheep.—There has been much dispute regarding the essential symptoms and the causal organism of braxy. What may be called the old school considered the disease to be due to an anaerobic, motile, spore-bearing bacillus, giving rise to an inflammatory condition of the fourth stomach. But the latest review of our present state of knowledge, by Dr. J. P. McGowan (*Centralbl. f. Bakteriol., Parasit., und Infektionskr.*, Jena, Bd. 91, 1923), shows that, in face of the criticism of continental workers and of the author himself, this view must be abandoned, for feeding or inoculation with the alleged causal organism fails to produce braxy. It would also appear that the symptoms usually considered to be those of braxy are in reality very rapid post-mortem putrefactive changes. Examination of very fresh carcases shows the abundant presence in pure culture of *Bacillus bipolaris septicus ovium*, inoculation with which reproduced the disease; and this would indicate that braxy is a hyperacute form of hæmorrhagic septicæmia. Sheep are predisposed to attack under conditions of lowered resistance, often dependent upon climatic factors, such as the presence of a large quantity of frosted grass in the food, or exposure to severe day and night fluctuations of temperature. Sheep which are feeding poorly seldom suffer from the disease, and to this fact the author attributes the success of the well-known pig-dung drench and of the "vaccines" prepared from non-causal bacilli, since both treatments throw the sheep seriously out of condition.

Insulin.—The chemisty of insulin is described in an article by Mr. Norman Evers in the *Chemical Age* for November 3. So far back as 1885 Mering and Minkowski noticed that complete extirpation of pancreas from dogs was followed within a few days by diabetic symptoms similar to those observed in human beings. Lepine suggested that the pancreas gave some secretion which controlled carbohydrate metabolism, and this view gained ground. Schafer suggested the name "insuline" for the secretion produced by certain groups of small cells in the pancreas. Many attempts were made to prepare an extract of the pancreas which on injection would reduce the blood sugar of a diabetic patient, but it was left for Drs. Banting and Best, working under Prof. J. J. R. Macleod at Toronto University, to crown these efforts with success. Mr. Evers describes the original method of extraction in some detail, and considers the subsequent improvements; he also treats of the purification, chemical properties, and of the other sources of the substance. Apparently, for the present, ox and pig pancreas are the only available economic sources. It will be recalled that an article by Prof. J. J. R. Macleod describing the action of insulin appeared in Nature of October 27, p. 625.

Tropical American Ascomycetes.—Among the Ascomycetes of Tropical America are several puzzling forms of Discomycetes, which in habit recall rather the Basidiomycetous genus, Auricularia. Just before his death the late Prof. Durand had revised a number of these forms, and his findings have been published by Dr. Roland Thaxter, with some notes and two plates of figures added. The long-established genus, Midotis Fr., is now clearly characterised for the first time, whilst some other curious species, including some previously grouped under Cordierites Mont, are now placed in a newly formed genus, Ionomidotis Durand. Seven species of this new genus are described, and a key supplied for their identification.

Control of Disease in the Palmyra Palm.—Something of the problem involved in carrying out remedial methods in phytopathology is to be seen in the report by W. McRae, appearing in the Memoirs of the Department of Agriculture in India, volume 12, No. 11, July 1923. In 1905 Dr. E. J. Butler identified *Phytophthora palmivora*, Butl., as the cause of the serious disease of the Palmyra palm, *Borassus flabellifer* Linn., occurring in the Madras Presidency. This palm is of great importance to the native community both for its fruit and for its use as the source of a fermentable liquid used in the preparation of toddy. For the latter purpose the leaves at the apex of the shoot are cut. Older leaves are sometimes cut also for use either as fuel or as a source of fibre. Control of the disease has involved the cutting, removal, and burning of the green tips of diseased trees and then, as experience showed it possible, the removal of outer diseased leaves from less severely affected trees, which then frequently recovered from the disease. The author concludes that, during the fifteen years in which the control operations which he reviews have been in progress, some three-quarters of a million palms have been saved, and he affirms definitely that the disease has been reduced from a grave menace in 1908 to a controlled problem at the present time. The operations, carried out by native workers under the supervision of a special staff recruited from the Revenue Branch of the District Administration, are estimated to have cost 20,000*l*. for the period 1916–1921. Until the application of the Pest Act, everything had to be done with the acquiescence and co-operation of the villagers, the result being so careful an attention to propaganda and education in the reasons for remedial measures that during the first two years' operation of the compulsory clauses contained in the Pest Act only one prosecution has proved necessary.

The Theory of Isostasy.—At the meeting of the Royal Geographical Society on November 12, two papers discussing the theory of isostasy from very divergent angles were presented. The briefer one, "Doubts and Suggestions on Terrestrial Isostasy," by Captain Alberto Alessio, is critical of Hayford's method of treating Pratt's hypothesis: his assertion that the field of force of gravity, being observed only at a limited number of points, can be produced in an infinite variety of ways by appropriate distributions of density may be assented to; but he brings forward no arguments of sufficient weight to explain away the value of Hayford's simple general hypothesis as to the distribution of density under mountain or oceanic regions, as a means of accounting for variations in the gravitational field. The second paper, on "Abnormal Densities in the Earth's Crust disclosed by Analysis of Geodetic Data," is by Prof. W. Bowie, of the United States Coast and Geodetic Survey, who has continued Hayford's isostatic researches. It is a valuable and interesting résumé of the present state of the theory, indicating both its many successes and the extent to which it is to be regarded as a simplification—for purposes of preliminary analysis and computation—of the probable real facts. The anomalies or differences of the observed gravity data from the values calculated by Hayford's method are shown to be much less than those from the values calculated by Bouguer's method, in which no account is taken of the isostatic compensation. It is also shown that the Bouguer anomalies increase rapidly for elevated stations, while the "isostatic" anomalies show a purely normal accidental distribution. Even so, a considerable class

of cases in which the isostatic anomalies suggest decided departures from isostatic equilibrium can be reasonably accounted for by what may be regarded as a second approximation to the facts; the simple Hayfordian theory is that the compensating excess or defect of density is distributed uniformly throughout a column of a certain depth, independent of locality. Prof. Bowie has shown that in many cases there is geological evidence for the existence of heavier or lighter rocks (as the case may be) nearer the surface, and that these are capable of accounting for many of the anomalies referred to, without supposing the isostatic compensation to be incomplete.

CARBONISATION OF COAL.—The Fuel Research Board has issued a report (Technical Paper No. 8) on "The Steaming of Wigan Arley Coal in Vertical Gas Retorts" (H.M.S.O., 9*d.* net). It sets out the results which were obtained when this particular coal was carbonised with gradually increasing quantities of steam in the Glover-West vertical retorts of the Fuel Research Board's experimental station at Greenwich. The coal is one largely used for gas-making in Lancashire, and the tests on it were carried out "at the request of the Preston Gas Company, the Wigan Coal and Iron Company, Ltd., and Messrs. West's Gas Improvement Company, Ltd., these firms combining to bear the cost of 300 tons of coal for the purpose." A large amount of detail as to the results obtained finds its place in the text of the report, and particularly in tables given at the end, from which it is plain that an attempt has been made to secure as much information as possible during the tests for the guidance of gas engineers who may be thinking of using this coal. It is interesting to note that some data have been acquired for the fuel consumption, as reported thus: "The amount of heat required per ton for the carbonisation of this coal, including the sensible heat in the products, varied from 13·0 therms with 5 per cent. steam to 18·25 therms with 20 per cent. steam. The intermediate points were not obtainable owing to the amount of heat which was taken up by the setting when only three retorts were in use being unknown."

TEMPERATURE-MEASURING INSTRUMENTS.—A useful booklet of 71 pages has been issued by the Cambridge and Paul Instrument Company, in which a concise account is given of the various temperature-measuring instruments made by this firm. A perusal of its contents shows that the number of useful devices applicable to the measurement of temperature is continually increasing, so that the user has now a much wider choice than heretofore. Descriptions are given of dial and index thermometers, the latter being provided with an electric alarm attachment for ringing a bell when the temperature differs from that at which it is desired to work. With both these types continuous records may be taken on charts by means of a moving pen. In connexion with platinum resistance thermometers, direct-reading indicators for any assigned range are provided, in which the movements of the pointer depend upon the extent to which a Wheatstone bridge is thrown out of balance by the varying resistance of the platinum at different temperatures. Thermo-electric pyrometers, with base-metal and rare-metal couples and suitable indicators and recorders, are described; a form used for measuring surface temperatures, and methods of cold-junction control, being of special interest. Amongst radiation and optical pyrometers, a description is given of a recent pattern of the disappearing filament type, capable of reading to 2100° C. A new feature is the introduction of devices for the automatic control of temperatures, either of gas or electric furnaces or tanks of liquids. Control is effected from the indicator by means of a relay, which comes into action when the required temperature is reached, and operates a mechanism which regulates the supply from the source of heat. The instruments described under this head represent a distinct advance in temperature-measuring appliances.

"FISHING" IN OIL-WELL DRILLING.—Fishing is a term employed by the driller to cover a multitude of different operations connected with the drilling of oil-wells, but it is invariably synonymous with trouble of some kind or other, and always calls for the greatest skill and ingenuity on the part of the operators concerned. Technically speaking, the processes of side-tracking of tools, casing, or similar obstruction, frequently necessary in emergency, also come within the purview of "fishing jobs." The recovery of lost or "stuck" tools, runaway tools, broken ropes or rods, lost or broken casing, the removal of "frozen" pipe or other obstacle impeding the drilling of the well—these are some of the many kinds of trouble experienced by the driller. Fishing methods differ with the type of drilling system in vogue, with the efficiency of the drilling crew, and to a large extent according to the country in which the oil-field is situated. It should be borne in mind that operations of this character are usually lengthy, tedious, and expensive, since while they are being carried out the well certainly cannot be earning any money; consequently producers are becoming more and more alive to the necessity for reducing fishing operations to the absolute minimum, by the employment of the most skilful drillers, equipped with the most up-to-date tools and devices for achieving the desired results. Drilling is becoming more and more of a science, less of routine manual labour; it is therefore valuable to have the advantage of a paper such as Mr. Albert Millar's, read on November 13 before the Institute of Petroleum Technologists, dealing with the Galician-Canadian pole tool fishing methods, which provided a natural sequel to his previous paper on the same system of drilling for petroleum.

MERCURY AS A WORKING SUBSTANCE FOR BINARY FLUID TURBINES.—The possibilities of the use of mercury in this connexion were discussed in a paper read by Mr. William J. Kearton before the Institution of Mechanical Engineers on November 16. No fluid exists which possesses the ideal conditions for a single fluid turbine; hence the use of two fluids—one having a high boiling-point to be used in a high-temperature turbine, and the other with a low boiling-point to be used in a low-temperature turbine. Mercury may be used for the first fluid and steam for the second. It is stated that an experimental mercury-vapour turbine has been built in the United States by the General Electric Company to the designs of Mr. Emmett, and that a second turbine has recently been put into operation. There does not appear to be any published information on the subject in Great Britain. A considerable amount of experimental work has been done by chemists and physicists on the properties of mercury, but all the data required for a complete study of the problem are not at hand. A large amount of research work, particularly in connexion with the determination of latent heats at high temperatures, remains to be done. A considerable part of Mr. Kearton's paper is taken up with a discussion of the properties of mercury, and the results obtained by many workers are reviewed. The author has calculated tables giving the relation of temperature, vapour pressure, sensible heat, latent heat, total heat, entropies of the liquid, of evaporation, and of the mercury vapour; these tables appear in the paper, and are supplemented by diagrams showing the properties graphically.

The Royal Society Anniversary Meeting.

INSTITUTION OF RESEARCH PROFESSORSHIPS.

AT the anniversary meeting of the Royal Society held on November 30, the report of the Council was presented and the president, Sir Charles Sherrington, delivered his address. The report of the Council refers mainly to the chief benefactions made to the Society for the promotion of scientific investigation. These are the gift of 100,000*l*. made by Sir Alfred Yarrow in February last, a bequest of 50,000*l*. by Dr. Ludwig Mond, which came to the Society through the death of Mrs. Mond in May last, 500*l*. a year for at least five years from the Worshipful Company of Armourers and Brasiers, the Foulerton gift of 20,000*l*. and the bequest by Miss L. A. Foulerton of the residue of her estate, and the Messel bequest of four-fifths of the residuary estate. The income from the present investments of the four funds available for the endowment of scientific research is approximately as follows: Foulerton gift, 1000*l*.; Foulerton bequest, 4050*l*.; Messel fund, 1575*l*.; and Yarrow fund, 5450*l*. No income has so far been received from the Mond fund, but, according to the terms of the will, it is anticipated that there will be an annual income of about 2500*l*.

Upon the receipt of Sir Alfred Yarrow's gift, a committee was appointed by the Council to consider and make recommendations as to the general use and administration of the Foulerton, Messel, Yarrow, and Mond funds. Following a recommendation of this Committee, the Council resolved that in the first place the remaining sums of 250*l*. to be paid in respect of the yet unpublished volumes of the Royal Society Catalogue of Scientific Papers be paid out of the income of the Mond fund, and that after this the deficit of the Royal Society's publication fund should be met each year by contributions from the Messel fund and from the Mond fund, these contributions being made in so far as convenient in proportion to the total incomes of these two funds. It was further resolved on the recommendation of this Committee that the chief remaining part of the income from the various funds be used in the endowment of certain Royal Society professorships, these to be awarded to men only of proved ability for independent research; and regulations have been adopted both for the endowment of these professorships and for the endowment of scientific research in other ways out of the residue of the various funds. Detailed regulations for the administration of these four funds and for the appointment to and tenure of Royal Society research professorships have been adopted by the Council, and a separate Committee has been appointed to make recommendations as to the administration of the Yarrow fund.

Photo] [*Elliott and Fry, Ltd.*
Prof. A. Fowler, professor of astrophysics, Imperial College of Science and Technology.

Mr. G. I. Taylor, fellow and lecturer in mathematics, Trinity College, Cambridge.

YARROW RESEARCH PROFESSORS OF THE ROYAL SOCIETY.

Sir Charles Sherrington devoted his address almost entirely to an account of the institution of these research professorships and the policy adopted by the Society in regard to this means of securing the advancement of natural knowledge. It is felt that professorships endowed in the way described, so as to be mobile both as regards the University at which they are held and the subject of research, are of enormously greater value than professorships or fellowships tied for all time to a particular university and a particular subject.

The portions of the president's address referring to the use of these endowments, and to the work of this year's medallists, are printed below in a slightly abridged form.

SIR CHARLES SHERRINGTON'S PRESIDENTIAL ADDRESS.

At the anniversary meeting it cannot be out of place to iterate the main object of the Society's foundation—" the improvement of Natural Know-

ledge," by discovery, and as a never-failing means to that end, the furthering of research. A reference made to it at last year's anniversary dealt particularly with the funds at the disposal of the Society for assisting that great purpose. To-day, in reviewing, however briefly, the events of the past year, the Society recalls with lively gratitude the noble gift received from one of its fellows, Sir Alfred Yarrow. It is a gift specially directed towards this same essential aim of the Society's existence. The terms of Sir Alfred's letter accompanying the donation were no less generous and public-spirited than the gift itself. The letter stressed "that the money be used to aid scientific workers by adequate payment and by the supply of apparatus or other facilities, rather than to erect costly buildings."

The receipt of this splendid gift was followed at no long interval by the accruing to the Society of the valuable bequest from its past fellow, the late Dr. Ludwig Mond. The accession of these funds to the means at the Society's disposal for advancing research has enabled, and suggested, systemisation of its provision for that end. Consideration was undertaken of some adjusted scheme whereby the disbursements the Society could hope to make for the furthering of research should keep suitably in sight the whole ambit of the Society's purview of natural knowledge, thus making for advance over a wide scientific front. For such a plan the Foulerton, Messel, Yarrow and Mond funds, to mention them in their historical sequence, taken in conjunction and following the wishes of their individual donors, lend themselves well. The scope of destination of these funds extends from physics, chemistry, and engineering, on one hand, through biology, to, on the other hand, "Medicine and such sciences as are connected with the discovery of the causes of disease and the relief of human suffering." The mere scant enumeration of the circle of the natural sciences suffices to show them as a band of brothers, and seeing them as such is to remember their call is for research, and not even solely for science's sake itself, but for that of humanity as well.

In addition to the question of the breadth of field there remained that also of the particular form which help for research might take in order to be best effective in whatever field rendered. The consideration given to this has been very full and careful. It will be recalled that from the Donation fund and from some other funds of smaller amount, and also through the Committee administering the annual Government grant, the Society is able annually to make disbursements helpful for apparatus and material in response to applications in regard to particular items of research. Moreover, the Society has of research studentships five in addition to the Sorby fellowship. All and each of these have rendered and are rendering valuable aid to scientific research in their several respective ways. Broadly taken, their destination is to workers of promise in the earlier period of their career; and such workers are thus provided with opportunity for proving the powers of their promise. This year, in addition to the above, a generous and public-spirited step taken by the Worshipful Company of Armourers and Brasiers enables the Society to participate responsibly in the management of yet another endowment of somewhat similar scope.

Bearing in mind this relatively satisfactory provision already existent for these needs and recognising, further, the far-reaching outside provision available from Governmental and a number of public and private beneficiary sources, to meet requirements of a similar kind, the opinion arrived at after thorough consideration has been that a form of help specially called for, and specially likely to be effective in advancing discovery, would lie in the creation of greater opportunity for fully experienced investigators of already proven first-rate capacity in research. It is felt that increase of opportunity afforded to such investigators is likely to attain, with a prospect of comparative certainty, its recompense in the achievements such investigators will accomplish.

To open up facilities for this class of investigator would seem particularly the province of the Society, and one in which its help could pursue required directions with especially whole-hearted conviction, because the Society, in virtue of its own organisation, has special opportunity for cognisance of the powers and scientific circumstances of representatives of this class of investigator. Over an ample field, and at many points in that field, the Society lives in contact with their endeavours, conversant with work they have already done and often with work they are, in fact, prosecuting, and could prosecute more fully had they increased opportunity for so doing. The desirability for encouragement of research from the Society to take this kind of shape seems enhanced by circumstances of the present time, including as this present time does the likelihood of an immediate future which will be one of anxiety for finding ways and means. In institutions, university or other, for the most part such investigators occupy positions to which their opportunities for research attach rather as a secondary adjunct to calls of other nature upon their strength and time. Under an institution's financial stress the demand made by it upon members of its staff who have multifold duties other than research, is likely to be increased in directions away from research. This is a situation of hardship to the investigator and of detriment and mischance to the due advance of science itself.

Institutions, whether university or other, which are seats of learning, show themselves, in instance after instance, desirous for their personnel to prosecute research, but also, in instance after instance, embarrassed to secure to them adequate time for doing so. Yet the research activity of these men—or, for that matter, women—is a main source of that improvement of natural knowledge which it is the Society's great business to promote. A spring of indispensable supply for the production of new knowledge is thus stemmed or curtailed. Therefore, it is felt that the Society, by securing, in co-operation with this or that particular institution, ample freedom of time for a distinguished member of the personnel there to prosecute research undividedly, may extend a form of help toward the advance of discovery particularly desirable and welcome. It is felt that by so doing the Society can gear most usefully its own motive help into the general existent running machinery for the production of new scientific knowledge. The hope is, and the belief is, that its action may thus provide exactly a something which other institutions might have special difficulty in providing. The action it is taking marks a course which, although entered upon tentatively and to be judged finally by experience, is yet inaugurated with the foundation of three research professorships of the Society. The regulations for these appointments have been drawn up with intention to give the professors the utmost freedom to carry out research in the way dictated by their individual attainment, temperament, and inclination. The Council has not thought fit to insist that the professors either shall teach or shall not teach; the sole restriction laid down is that to research shall their main energies be devoted.

At the anniversary meeting last year I had the pleasure of referring to the appointment, then literally scarcely more than one hour old, of Prof. Starling as Foulerton professor. This year has seen him Harveian Orator of the Royal College of Physicians and, as regards the Society, entered fully upon the actual

activities of the Foulerton professorship. Now at this present anniversary, the pleasurable privilege falls to me of announcing the appointments of Prof. A. Fowler and Mr. G. I. Taylor to the Yarrow professorships. I may be allowed here a brief reference to their work. I follow the alphabetical order of their names. Prof. Fowler is known the world over as a spectroscopist whose researches have been of the greatest value to astronomy, to physics, and to chemistry. Entering on science first as a pupil of, and then as an assistant to, Sir Norman Lockyer, his earlier researches were, at that provenance made natural, astrophysical in kind, although the special technique which he developed was a technique of methods purely laboratory. He achieved extraordinary success in identifying lines observed in stellar spectra with lines which he was able to reproduce in the laboratory; he was able thus to assign the lines to their chemical origin. For example, the origin of the bands which dominated the spectra of what were then described as stars of Secchi's third class had been a mystery for many years. Fowler was able to show that they were due to titanium oxide. He accounted for many of the bands in the sun-spot spectrum by showing that they belonged to magnesium hydride. Again, he made an interesting study of the spectra of comets. The spectrum of the head had been observed by Donati in 1864 and had been fully studied by Huggins and others. It remained for Prof. Fowler to make a study of the tail spectrum of comets. He noticed first that the observed spectrum coincided with one which had been obtained in the laboratory arising from an impurity in low-pressure hydrogen. Finally, after much effort and laborious work, this spectrum was found to originate in carbon monoxide.

While these are perhaps some of the more striking of Prof. Fowler's successes in the region of astrophysics, he has also done a great deal of highly useful work in adding to our knowledge of the spectra of known terrestrial substances. Special mention may perhaps be made of his study of the spectrum of scandium, which proved to be important both in solar prominences and in sun-spots; of magnesium, in which he discovered new series of spectral lines; of strontium, in which he added several lines to the already known triple series; and of the active modification of nitrogen discovered by the present Lord Rayleigh.

At the time that these investigations were carried out, there was no reason to suppose an immediate future of practical importance for the results obtained, but with the advent of Bohr's theory of atomic structure, they have been found to provide exactly the material required for full discussion of the new theories of atomic structure, and for the acquisition of new positive knowledge as to the details of atomic mechanism. Perhaps his success of most striking general appeal has been his direct experimental proof that the so-called ζ-Puppis series of hydrogen originate from helium and not from hydrogen at all. This result incidentally provided a striking confirmation of Bohr's theory of the origin of spectra.

In this field of research Prof. Fowler stands unrivalled. Recently he has been examining the changes which take place in the spectra of elements as one electron after another is removed; the results obtained are of fundamental importance. His last paper, on the "Spectrum of Trebly Ionised Silicon," will still be fresh in the minds of many of our fellows.

Branches of physical science other than those benefiting by Prof. Fowler's work have formed the field of research of the Society's other Yarrow professor, Mr. G. I. Taylor, namely, mathematics, engineering, and geophysics. Mr. Taylor started his scientific life as an applied mathematician, and the Society is still fortunate in receiving from him frequent mathematical papers on hydrodynamical themes. Before the advent of Mr. Taylor to this field, it was almost a foregone conclusion that the results of mathematical research in a large part of hydrodynamics would not be confirmed by experiments; Mr. Taylor has opened an era in which experiments and analysis give confirmatory results. From abstract hydrodynamics he was led to research in practical problems of geophysics and meteorology. He has a distinguished record in aeronautical science, dating from the time when, acting as Meteorological Adviser to the Air Force, he was led to study the motions of the air, the causes and effects of eddies and the complicated phenomena to which these give rise. The application of much of his work to problems connected with aircraft is very direct. As the result of mathematical calculations he designed a parachute possessing many advantages in practice; quite recently he has published an important theoretical investigation as to the manner in which the forces on a model aeroplane in a wind-channel are affected by the eddies set up at the channel's mouth. Some contributions by him have proved of high value to the theory of the propeller. He has taken a leading part in the development of a theory which goes far to account for the forces of an aeroplane in terms of the circulation round it, and the series of trailing vortices shed from its wings.

Mr. Taylor has been equally successful in the application of mathematics to engineering problems. In collaboration with Mr. A. A. Griffiths, he was the first to utilise the fact that the equations which determine the torsion of an elastic bar are identical with those representing the displacement of a thin membrane stretched over a hole of suitable shape when slightly distorted by uniform pressure. By micrometric measurements of the distortion of such a membrane, he was able to deduce the torsion stresses inside a bar of specified cross-section, a procedure having practical applications of the greatest importance.

In the last Bakerian lecture delivered before the Society, Mr. Taylor, in conjunction with Miss Elam, studied the strains in a single crystal of aluminium when stretched to breaking point, using a most ingenious combination of micrometric measurements and X-ray analysis. In this way he was able to trace the internal motions in the crystal and to explain the striking difference between the fracture of a bar of ordinary metal and that of a single crystal, such as he examined. In this, his most recent work, he has opened up a field which promises to be of far-reaching importance to the science of the strength of materials, and, I venture to think, of great practical value to the working engineer.

The record of both of our new professors gives every justification for hoping that in the unfettered freedom of the Yarrow professorships they may find the opportunity for still more ample fulfilment of brilliant work. It is fortunate that they will both continue their researches in the laboratories from which their outstanding work has issued in the past, and of the traditions of which their reputations already are, indeed, a part.

Finally, may I in general terms return once more to summarise that leading motive, which has actuated the launching of these new professorships. Our universities and other scientific institutions have been wont—indeed in many cases by force of circumstances are compelled—to regard teaching as the primary occupation of professoriate and staff and to envisage their occupation by research as merely secondary to their occupation in routine teaching. The Society has inverted quite deliberately that

order of precedence of professorial function. By this inversion the Society of set purpose desires to recognise research as a definite profession and to advance, and to maintain, the principle that the labourer is worthy of his hire no less when engaged in research than when engaged in class instruction.

Yet one word more upon this subject. Munificent as the gifts are which the Society has received, enabling it to do what it is doing toward this end it has at heart, may we not venture to hope that the funds already to hand for that purpose will prove but the auspicious starting-point for yet others of similar destination. To say this is but to echo the concluding sentence of Sir Alfred Yarrow's memorable letter. With such aspirations, our desire is that in due course either the Royal Society or other bodies may have it in their power to endow the research of all those individuals whose life ought, in the best interests of the community, to be devoted to scientific research as the main purpose of their life-career.

THE MEDALLISTS.

COPLEY MEDAL. Prof. Horace Lamb.—For forty years Prof. Lamb has been recognised as one of the most prominent and successful workers in applied mathematics in Great Britain. He is the foremost authority on hydrodynamics, not only in Great Britain but the world over. Prof. Lamb's scientific activity, originally centring around the subject of hydrodynamics, has radiated thence into most branches of physical science and he may be regarded as the outstanding representative to-day of the school founded by Stokes, Kelvin, Clerk Maxwell, and Rayleigh. In recent years he has made important contributions to seismology, the theory of tides, and other branches of geophysics. Specially perhaps should be mentioned the assistance he has given of recent years to the Aeronautical Research Committee. Mathematical questions involved in the flow of air round aircraft, in the action of propellers, and the stresses in aeroplane structure, are of fundamental importance, but are exceedingly difficult; and here, as elsewhere, Prof. Lamb's mathematical skill and power of clear exposition have proved of the highest value.

ROYAL MEDAL. Prof. Charles James Martin.—Prof. Martin is distinguished for contributions both to physiology and to pathology. Investigating snake venoms, he differentiated two groups in virtue of their action, one nervous, the other, so to say, humoral. His work on heat-regulation in monotremes threw light on the evolution of the thermotaxis of warm-blood animals. More recently his researches have lain in the colloidal chemistry of proteins, and in protein-metabolism. As Director of the Lister Institute he has contributed to many investigations, in addition to those actually issued in his name. Thus he has been intimately associated with the inquiry into the influence of accessory food factors of diet in the prevention and remedying of "deficiency" diseases, such as scurvy and rickets, an inquiry the success of which may be regarded as one of the recent triumphs of preventive medicine.

ROYAL MEDAL. Sir William Napier Shaw.—In the great advances made during the last twenty-five years in the science of meteorology, Sir Napier Shaw has been amongst the foremost pioneers. During his twenty years' administration at the Meteorological Office, that Office saw three marked steps forward: two of these were changes in its quarters; the third and greatest was the change in outlook of the work of the Office, whereby it assumed, under Sir Napier Shaw's stimulating influence, the character of a scientific institution for the interpretation of meteorological phenomena. With the assistance of his scientific staff, he has developed the physical and dynamical aspects of the subject, and has done much to concentrate attention upon the thermodynamics of meteorology, wherein the motions of the water-laden air are interpreted as the action of a thermodynamic engine. His contributions to knowledge of the air and its ways have been largely responsible for changing the basis of meteorology from one of empiricism to one of science.

DAVY MEDAL. Prof. Herbert Brereton Baker.—Prof. Baker's researches in various fields of chemical investigation, his examination of highly purified tellurium from various sources for the possible presence of higher members of the same group of elements, and the redetermination of its atomic weight, are of outstanding merit. It is, however, his remarkable researches on the influence of traces of water in modifying chemical change, whether of the nature of combination or of decomposition, which constitute perhaps his especial distinction. The results obtained by complete drying were as remarkable as they were unexpected, because they were in direct opposition to those which followed careful drying by usual methods. The bearing of Prof. Baker's researches on theories of chemical change is as important as his conclusive experimental demonstrations of the phenomena themselves.

HUGHES MEDAL. Dr. Robert Andrews Millikan.—Dr. Millikan has long been regarded as one of the most skilful experimenters in physical science. He is awarded the Hughes medal especially for his determinations of the electronic charge e and of Planck's constant h. When physicists were still ignorant of the value of the electronic charge to within 5 per cent., Dr. Millikan, by a method of the utmost ingenuity, arrived at the value $4{\cdot}774 \times 10^{-10}$ E.S.U., for which he claimed an accuracy of one part in a thousand, a claim which has stood the test of time. His determination of h was not only remarkable in itself, but was of still greater value as finally vindicating the Einstein-Bohr view of the nature of the photo-electric phenomenon.

University and Educational Intelligence.

EDINBURGH.—Dr. Theobald Smith, of the Rockefeller Institute for Medical Research, New York, United States, gave an address in the University on Tuesday, November 27, on comparative pathology. He emphasised the common basis—theoretical and biological—of human and animal pathology; the divergence in methods of treatment of human and of animal patients is determined in the case of the latter by economic considerations. He urged that individual treatment of animals should be replaced more and more by preventive measures, and that future stock-owners should be brought to realise this by a sound education in the principles underlying disease.

LIVERPOOL.—Sir Heath Harrison, Bart., founder of the chair of organic chemistry in the University, has generously contributed a further sum of 2500*l.* towards the endowment of the chair.

DR. C. E. WEATHERBURN, of Ormond College, Melbourne, has been appointed professor of mathematics at Canterbury University College, Christchurch, New Zealand.

The Annual General Meeting of the Association of Women Science Teachers will be held on Saturday, January 26, at University College, London. In the afternoon Miss Elles will lecture on "The Scientific Interpretation of Scenery" and the meeting will be open to all who are interested in the subject.

In London, Ontario, the corner stones of the new arts and science buildings of the University of Western Ontario (formerly known as the Western University of London) were laid on June 18 last by the Premier of the Province. The cost of the buildings, more than a million dollars, is being provided for chiefly by grants from the provincial and county governments. The University has grown rapidly in recent years, its student enrolment (610) being three times as large as before the War.

A professor of botany and director of the biological laboratories in the University College, Colombo, Ceylon, is required. Candidates should hold a first-class honours degree of a British University, with botany as the principal subject, or equivalent qualifications, and have a competent knowledge of plant physiology, with an acquaintance of botany as applied to agriculture either as plant pathology or genetics, or soil biology. Further information of, and application forms for, the appointment are obtainable until December 15, from the Assistant Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1. The completed application forms must be returned by January 1.

Among "significant movements in city school systems" described in Bulletin No. 8 of 1923 of the United States Bureau of Education is the increase in size of the school buildings and grounds. In the larger cities buildings with 24 or more rooms are beginning to appear. This movement is partly due to the insistent modern demand for adequate provision in connexion with city schools for recreation, for physical training, and for practical work. In many cities it has been found that the expense involved in providing for these activities the requisite gymnasiums, auditoriums, manual training shops, home-economics and science laboratories, drawing and modelling studios, and playgrounds, while maintaining class rooms on the same scale as before for ordinary class instruction, is prohibitive. The "platoon," or "work-study-play," or "duplicate school" plan divides the school children of all grades into two groups—A and B. While those of group A are in the class rooms those of group B are in the playgrounds, auditorium, laboratories, or other specially equipped rooms, and vice versa, so that the school can be run with half the number of class rooms required under the ordinary system. Such schemes have been introduced in 53 cities, and in one of these more than 50 "platoon" schools are established.

The Cincinnati public-schools psychological laboratory is responsible for an interesting attempt to trace the causes of failure in first and second-grade work of children not classified as mentally deficient. The experiment was carried out in an "observation class" of sixteen children from 1917 to 1921, and a detailed account of it has just been published in "Diagnosis and Treatment of Young School Failures"—Bulletin No. 1 of 1923, of the Washington Bureau. Diagnosis should, the writer declares, take account of the child's mental level (as indicated by the various intelligence tests), school history, state of health, general mental tone and attitude (*e.g.*, obsessions, phobias, or anxiety-states), and heredity. Treatment in the observation class resulted uniformly in improvement as measured by mental tests notwithstanding that operative correction of physical defects such as removal of diseased tonsils and adenoids was, owing to parents' objections, in no case effected and unfavourable home conditions remained unchanged. Pleading for a widely extended development of psychological and medical clinics and other extra-class-room resources, the writer remarks, "The community-wide contacts of the school and its hold on the family through the child give it a strategic position for the discovery and diagnosis of mental, physical, and social ills which no other agency can possibly equal."

The annual meetings of the Geographical Association will be held in Birkbeck College, London, on Wednesday, Thursday, and Friday, January 2, 3, and 4, 1924. The programme includes the following items:—Jan. 2, Prof. P. M. Roxby will open a discussion on "Regional Study in the University and the publication of its results"; Jan. 3, Mr. L. Mac D. Robison will give an address on Ceylon; Sir Richard Gregory will give his presidential address on "British Climate in Historic Times"; joint conference between the Royal Meteorological Society, the Geographical Association, and the Science Masters' Association, to consider the place of meteorology in education. Sir Napier Shaw will preside. Subjects of discussion: "The Place of Meteorological Observations in the School Course," and "The Teaching of Meteorology and Climatology in Schools from (1) the physical and (2) the geographical standpoint"; and M. Em. de Martonne, professor of geography in the University, Paris, will speak (in English) on "A Study of Transylvania"; Jan. 4, conference on railway geography. Mr. Alexander Bell, Assistant General Manager, L. and N.E. Railway, in the chair. Opened on behalf of the Geographical Association by Mr. Ll. Rodwell Jones and Mr. C. B. Fawcett.

In 1919, arising out of a suggestion put forward by the Universities Bureau of the British Empire as to the desirability of establishing a scheme for the interchange of students between the Universities of Great Britain and America, the Imperial College of Science and Technology, S. Kensington, with the generous assistance of two of its governors, Sir Arthur Acland and Sir Otto Beit, initiated as an experiment a project designed to afford to selected Imperial College students a year's post-graduate study either at an American university, or in American works. The hope of the founders was that the awards might not only prove mutually advantageous to the students of the two countries, but also that a closer acquaintance would tend to foster a spirit of good fellowship and mutual understanding between the students of the two countries and the countries themselves. The original scheme contemplated 6 scholarships of 300*l*. each for one year, which the Imperial College made 400*l*. a year, and later Sir Alfred Yarrow generously contributed a sum sufficient to provide 4 additional scholarships. In all 12 scholars were sent to America, 10 with, and 2 without emoluments; 6 of these went to the Massachusetts Institute of Technology, 2 to Columbia University, 1 each to Cornell, Harvard, and Yale Universities, and 1 spent the year with the Tennessee Iron Coal and Railroad Co., and other works. Five of the scholars were awarded the degree of master of science at the conclusion of the year, and arrangements were made in three cases by the American institution for the students to remain for a second year. Judging from the reports which have been received, the experiment has been an undoubted success. The awards have been discontinued as the funds have been exhausted.

Societies and Academies.

LONDON.

Royal Anthropological Institute, November 6.—Prof. C. G. Seligman, president, in the chair.—Miss M. A. **Murray**: The Percy Sladen Memorial Fund Excavations at Borg en Nadur, Malta. The apsidal building found last year was completely excavated, and further excavations were carried on to the east and south. The main entrance to the megalithic enclosure was cleared; on each side of the gateway was a tall megalith, and just within the enclosure on each side was a small chamber built of megalithic blocks. In an angle of each of these chambers a pot of the Bronze-age was found, evidently in position. The enclosure wall curves away from the main entrance towards the south and west; but there was not time to clear this completely. The outer blocks of the apsidal building were laid bare; they occur only round the west end and the north-west apse. Originally, they were probably six feet or more in height; now, however, they are about three feet high, as the tops have been broken off to bring them to the level of the field. Numbers of small flint implements were found in all parts of the site, chiefly in and near the apsidal building. To the west of the apsidal building the so-called "Neolithic stratum" was clearly marked, the earth being of a different colour from that above and below, and Neolithic potsherds occurring in large numbers. As this part of the excavation was at the boundary of the next field, it was not possible to continue the excavation further in that direction. It is hoped that the Maltese Government will buy the fields which contain the megalithic structures, and thus ensure that all the buildings of Borg en Nadur may be completely excavated.

November 20.—Prof. C. G. Seligman, president, in the chair. L. H. **Dudley Buxton**: The inhabitants of Inner Mongolia. The inhabitants of Inner Mongolia may be divided into three classes—Mongols, Chinese, and Manchus. The Mongols only are discussed: they are usually divided into three groups—the Kalmucks, the Buriats, and the true Mongols. This classification is based on linguistic relations alone. The majority of the true Mongols have adopted the Lamaistic form of Buddhism, but a number of relics of Shamanism survive, some of the rites being strongly reminiscent of Arctic hysteria. All their rites and ceremonies are in close harmony with their geographic environment, and are closely related to their occupations as pastoral nomads. Their physique differs from that of the Kalmucks and from many of the Buriat tribes. They seem to stand intermediate between the Turkish tribes of Central Asia, such as the Turguts and the Taranchi, and the Northern Chinese, although in many ways they are nearer the latter. They probably received a considerable infiltration of Western blood, perhaps akin to that of the Alpine race, possibly at a time which was contemporaneous with the culture represented in Fengtien by the Sha Kuo T'un pottery, although the actual people who occupied this site seem to have been early Chinese. If we regroup the Mongols on the basis of physique, most of the Kalmucks and many of the Buriats fall in a class akin to many of the Turki tribes, and distinguished for their extremely round heads, and to form a separate class which will include probably most of the true Mongols and the Buriats and possibly some of the Kalmucks. These are closely allied to the yellow races, although they, too, probably have a strain of white blood in their veins.

Physical Society, November 9.—Dr. Alexander Russell in the chair.—A. L. **Narayan**: Scattering of light by carbon dioxide, nitrous oxide, and some organic vapours. The light scattered laterally by the molecules of gases is not completely polarised, but contains a component polarised at right angles to the direction which is predicted by theory for a spherical molecule, the two components being conveniently referred to as the "wrong" and the "right" components respectively. Sunlight was used for illuminating gases and vapours, enclosed in a jointless tube. The strengths of the components were compared both by direct photometry and by photometric comparison of their effects on a photographic plate. Lord Rayleigh's results were confirmed, particularly in the case of carbon dioxide and nitric oxide. The difference in the scattering power of these two gases is contrary to the prediction of the Lewis-Langmuir theory of the atom.—A. **Ferguson**: On the measurement of the surface tension of a small quantity of liquid. If a small quantity of liquid, 1 c.c. or less, be placed in a vertical capillary tube, its surface tension may be determined by applying pressure to the upper end of the tube, and measuring the pressure necessary to force the liquid into such a position that the meniscus at the lower end of the tube is *plane*. Interfacial tensions may also be determined in this way.

The Faraday Society, November 12.—Sir Robert Robertson, president, in the chair.—A. J. **Allmand** and A. W. **Campbell**: The electrodeposition of manganese. The electrodeposition of manganese from aqueous solutions of its sulphate and chloride has been studied, and the effects of changes in composition of electrolyte, current density, temperature, and type of cell investigated. Pure manganese in coherent form can be prepared in small quantity with a current efficiency of 40-50 per cent., but attempts to prepare larger amounts in coherent form were unsuccessful.—S. **Glasstone**: The cathodic behaviour of alloys. Pt. I. Iron-nickel alloys.—A. L. **Norbury**: The volumes occupied by the solute atoms in certain metallic solid solutions, and their consequent hardening effects. When an element is distributed in solid solution as single atoms replacing single atoms of the solvent in the space-lattice of the latter, the hardening effect is, in general, proportional to the difference in size of the solute and solvent atoms. This relationship does not hold in certain exceptional cases—for example, silicon in copper and sodium in lead, which appear to arise when the solute has an exceptionally strong chemical affinity for the solvent. In such cases the solute probably exists in solid solution in the form of molecules of an intermetallic compound having a different space-lattice from that of the solvent. When an element forms a solid solution with another element, there is a contraction or expansion which seems to be large or small according to whether the chemical affinity between the elements is large or small.—J. B. **Firth** and F. S. **Watson**: The catalytic decomposition of hydrogen peroxide solution by blood charcoal. Blood charcoal previously heated to 120° C. shows moderate catalytic activity in the decomposition of hydrogen peroxide solution, but the activity is considerably increased by previous heating in a vacuum at 600° C. and 900° C., and is still further increased by previous sorption of iodine from solution. The activity of an activated charcoal consists of two types: α activity, which is very rapid, but ceases after a few minutes, and β activity, which may persist for several hours. In ordinary blood charcoal α activity is absent. The introduction of iron into sugar solution prior to carbonisation increases the

activity of the charcoal considerably, and it is suggested that the iron acts as a spacing agent. The proportion of hydrogen peroxide decomposed is determined by *both* the activity of the charcoal and the concentration of the solution.—E. E. **Walker**: The influence of the velocity of compression on the apparent compressibility of powders. The influence of the duration of the load on the volume ratio of compressed powder has been investigated, and the isobaric curve has been correlated with the value of the ratio resistance to impact to resistance to static load. The exceptional readiness with which powdered ammonium nitrate shrinks depends chiefly on the high value of its velocity coefficient.—L. **Anderson**: (1) An investigation of Smoluchowski's equation as applied to the coagulation of gold hydrosol. Colorimetric determinations of the rate of coagulation of gold sols by hydrochloric acid, potassium chloride, barium chloride, and aluminium chloride have been carried out, and a region of rapid coagulation is found in which Smoluchowski's equation holds fairly well. A slower region of coagulation is found in which the equation is inapplicable. On the whole, the equation in its present form is strictly limited to rapid coagulation. (2) The effect of sucrose on the rate of coagulation of a colloid by an electrolyte. The coagulation of gold sols by hydrochloric acid, barium chloride, and potassium chloride in the presence of varying amounts of sucrose has been investigated. It is concluded that sucrose exerts a definite peptising effect upon colloidal gold, and also that it exerts a specific augmentation of coagulation in the case of hydrogen and barium ions over and above that of increasing the activity of these two ions. It exhibits apparent antagonistic action towards ions and gold sols. The experiments indicate in general that the coagulating power of an ion is dependent upon its activity rather than upon its concentration, a conclusion which brings the typical colloid phenomenon of coagulation into line with the kinetics of chemical change in homogeneous (molecular) systems.—H. H. **Paine** and G. T. R. **Evans**: A method of measuring the rate of coagulation of colloidal solutions over wide ranges. The rate of coagulation of colloidal copper solutions has been studied for a wide range of electrolyte concentrations by making use of the retarding effect of starch. Very rapid coagulations can thus be brought into the region of observation by ordinary methods. A "transformation factor" can be obtained which enables one to calculate what the rate of coagulation would have been for the pure colloid. The results agree closely with the equation deduced by Freundlich for the variation of the rate of coagulation with the concentration of the electrolyte, and confirm the existence of a maximum rate of coagulation.—J. A. V. **Butler**: Studies in heterogeneous equilibria. Pt. I. The conditions at the boundary surfaces of crystals and liquids are discussed with the view of applying statistical methods to elucidate the kinetics of surface processes and to co-ordinate a number of different cases of heterogeneous equilibrium. A molecule near the surface is under the influence of two opposing attractive forces, that of the surface and that exerted by the liquid. In general, these result in a balance point at which the direction of the resultant force reverses. Suitable approximate statistical equations are deduced on this basis and applied to the simplest cases of solubility. The integration constants of the isochore for solubility calculated by means of the equations obtained for potassium, sodium, hydrogen, and silver chlorides, are of the same order of magnitude as the experimental values.

Royal Statistical Society, November 20.—Sir J. **Athelstane Baines**: The International Statistical Institute and its fifteenth session. The International Statistical Institute originated at the jubilee meeting of the Royal Statistical Society. During the War, its work was in abeyance, with the exception of that carried on by the Permanent Office, which had been established only a short time before hostilities began. The Institute was able to convene its fifteenth session to take place at Brussels last October. At the request of the League of Nations, through the Economic Section, proposals for the organisation of statistics for international comparisons were submitted to the Institute, and forwarded, as adopted, to the League. The subjects dealt with were statistics of trade, of agricultural production, and of fisheries, together with suggestions as to the use and form of index-numbers bearing on the economic situation. It is possible that the counsel of the Institute may be sought by the League systematically as time goes on, since the need of a qualified adviser, independent and impartial, upon international questions involving a statistical basis, is becoming annually more apparent.

PARIS.

Academy of Sciences, November 12.—M. Albin Haller in the chair.—J. **Costantin**: The collection and culture of *Pleurotus Eryngii*. Suggestions for the cultivation of this edible mushroom (and other species of Pleurotus) on waste land.—H. A. **Lorentz** and Edouard **Herzen**: The relations between energy and mass according to Ernest Solvay.—E. O. **Lovett**: A functional property of certain surfaces.—Armand **Cahen**: New continued fractions attached to certain operations.—Serge **Bernstein**: Quasi-analytical functions.—Jean **Chazy**: The gravitation field of two fixed masses in the theory of relativity.—Carl A. **Garabedian**: A method of series.—Charles **Nordmann**: The "turbulence" of the wind and the flight of hovering birds. Discussion and criticism of the views of Vasilesco Karpen on this subject.—Emile **Belot**: Some consequences of the fact that all stars, including the sun, must have passed through the nova phase.—J. **Rouch**: Researches on shoals with the aid of the divergent drag. This instrument, invented by Admiral Ronarch during the War for removing submarine mines, has been successfully applied to the detection of submerged rocks in the neighbourhood of the port of Brest.—René **Lucas**: Magnetic moments of rotation and molecular magnetic orientation.—R. **Ledoux-Lebard**, A. **Lepape**, and A. **Dauvillier**: The use of heavy gases in radio-diagnosis. Radiographs of a frog, before and after breathing krypton, show that this gas is as opaque to X-rays as the tissues of the animal.—Léon **Guillet**: The electrical resistance of commercial aluminium. The purest commercial aluminium has a specific resistance of 2·8 micro-ohms, and this increases with the amount of impurities. Silicon appears to cause a greater increase of resistance than iron. Mechanical treatment has only a slight effect on the resistance.—W. **Kuhn**: The decomposition of ammonia by ultraviolet light and the law of photo-chemical equivalence. The number of quanta absorbed per molecule of ammonia is between 2 and 2·5: this number is increased as the light is made more nearly monochromatic and is independent of the pressure and, in the interval 10° and 20°, of the temperature.—Pierre **Bedos**: Ortho-cyclohexyl-cyclohexanol. This is prepared, with good yield, by the interaction of cyclohexene oxide and cyclohexyl magnesium chloride. Only one of the two possible stereoisomers is obtained: other methods of preparation of this alcohol have given a mixture of the two isomers.—

P. **Gaubert**: The determination of minerals by the microscopical examination of the streak left on a hard body. The microscopical examination of the streak produced on a plate of ground glass or quartz can be used as a means of rapid identification of a mineral or of its constituents. It has the advantage of using only a minute weight of the material without damage to the specimen.—Sabra **Stefanescu**: The activity and correlation of the molars and maxillaries of mastodons and elephants.—René **Souèges**: The embryogeny of the Plantagaceæ. The development of the embryo in *Plantago lanceolata*.—J. **Dauvergne** and Mlle. L. **Weil**: A method of propagating by cuttings in a sterile liquid medium.—J. **Beauverie**: The yellow rust of wheat (*Puccinia glumarum*) in 1923.—Henri **Coupin**: The swelling of seeds and the osmotic pressure of the medium. From experiments on the swelling of seeds in sugar solutions of varying concentration it is shown that the osmotic pressure of the cells of seeds is generally high, from 20 to 45 atmospheres.—H. **Colin** and H. **Belval**: The levulosanes in cereals.—Ph. **Joyet-Lavergne**: The cytoplasmic structure of *Adelina dimidiata*, a parasite of *Scolopendra cingulata*.—Pierre **Danglard**: The vital coloration of the vacuolar apparatus in the marine peridians.—Jules **Amar**: Transformism and heredity.—L. **Fage** and R. **Legendre**: The lunar rhythms of some nereidians.—C. **Levaditi**, S. **Wicolau** and Mlle. R. **Schoen**: Etiology of encephalitis.

Official Publications Received.

Records of the Botanical Survey of India. Vol. 8, No. 4: Flora Arabica. By Prof. Ethelbert Blatter. Part 4: Labiateae-Ceratophyllaceae. Pp. 365-450. (Calcutta: Government Printing Office.) 1.6 rupees.

Report of the Botanical Survey of India for 1922-23. Pp. 10. (Calcutta: Government Printing Office.)

A Report of the Fifth Congress of the Far Eastern Association of Tropical Medicine held in Malaya, September 3-17, 1923. Edited by Dr. J. W. Scharff. Pp. 90. (Singapore: Government Printing Office.)

Statements laid before the Committee on Beri-Beri Control and the Resolution recommended by the Committee as amended by the Council and passed at the General Meeting of the Fifth Congress of the Far Eastern Association of Tropical Medicine. Pp. 12. (Singapore: Government Printing Office.)

Forest Bulletin No. 53: Summary of Results of Treated and Untreated Experimental Sleepers laid in the various Railway Systems of India, brought up to date. By R. S. Pearson. Pp. 23. (Delhi: Government Central Press.) 6 annas.

University of California Bulletin. Third Series, Vol. 16, No. 11: University of California Publications, Price List 1923. Pp. 89. (Berkeley, Cal.: University of California Press.)

Proceedings of the Cambridge Philosophical Society. Vol. 21, Part 6. Pp. 569-812+viii. (Cambridge: At the University Press.) 10s. 6d. net.

Livingstone College. Annual Report and Statement of Accounts for the Year 1922-23. Pp. 24. (Leyton, E.10.)

The Manchester Steam Users' Association for the Prevention of Steam Boiler Explosions, and for the Attainment of Economy in the Application of Steam. Memorandum by Chief Engineer for the Year 1922. Pp. 23. (Manchester.)

Diary of Societies.

MONDAY, DECEMBER 10.

VICTORIA INSTITUTE, at 4.30.—W. Dale: Egypt in the Days of Akhenaten and Tutankhamen.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Dr. A. T. Doodson: The Work of the Liverpool Tidal Institute.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (Annual General Meeting) (at London Day Training College), at 5.30.—Prof. Wynn-Jones: Vocational Tests in Music.

SOCIETY OF ENGINEERS, INC., at 6.—Annual General Meeting.

ROYAL SOCIETY OF ARTS, at 8.—Prof. A. F. Barker: Recent Progress in the Wool Industries (Cantor Lectures) (2).

TUESDAY, DECEMBER 11.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—L. R. McCollum: The Modern Rotary Drilling System.

INSTITUTE OF TRANSPORT (Metropolitan Graduate and Student Society) (at Institution of Electrical Engineers), at 6.—C. Anderson: Ministry of Transport Requirements, with reference to Railway Companies.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Adjourned Discussion on Paper read by E. W. Blocksidge at the Shipping and Engineering Exhibition on Life Saving Appliances on Large Passenger Steamers.

ROYAL PHOTOGRAPHIC SOCIETY (Scientific and Technical Group), at 7.—W. Clark: The Sensitivity of the Silver Halide Grains of a Photographic Emulsion.—Communications from the Eastman Kodak Research Laboratory.—L. A. Jones and E. Huse: The Relation between Time and Intensity in Photographic Exposure.—J. B. Capstaff and N. B. Green: A Motion Picture Densitometer.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—J. E. Barnard: Some Problems in Medical Microscopy.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—G. Herbert, R. A. Ives, and others: Discussion on Some Applications of Illuminating Engineering in Practice.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—G. Hewett: The Dusun of British North Borneo.

WEDNESDAY, DECEMBER 12.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 7.—W. P. F. Fanghaenal, W. N. Booth, and others: Discussion on The Lighting of Factories.

ROYAL SOCIETY OF ARTS, at 8.—Sir Frank Baines: The Preservation of Historic Buildings and Ancient Monuments.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. W. L. Templeton and Dr. H. J. Macbride: The Malaria Treatment of G.P.I.

THURSDAY, DECEMBER 13.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—H. B. C. Darling: The Trinomial Quintic.—H. D. Kloosterman: Representation of a Number in the Form $ax^2+by^2+cz^2+dt^2$.—Prof. Tadahiko Kubota: Some Inequalities concerning Ovals and Ovaloids.—W. L. Marr: The Occurrence of a Linear Determinantal System of Points.—Major P. A. MacMahon: Properties of Prime Numbers deduced from the Calculus of Symmetric Functions.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Kate Stevens: My Trip round the World.

INSTITUTION OF ELECTRICAL ENGINEERS at 6.—D. Brownlie: Pulverised Fuel and Efficient Steam Generation.

SOCIETY OF DYERS AND COLOURISTS (London Section) (at the Dyers' Hall, Dowgate Hill), at 7.—A. E. Woodhead: Colour Solvents and their Application to Textile Fibres.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—T. Smith: The Primary and Secondary Constant Magnification Surfaces of Thin Lenses.—W. Swaine: A Suggested Standard Trial Case and Simplification in Ophthalmic Policy.—B. K. Johnson: Exhibition of an Optical Revolution Counter.—D. Baxandall: Exhibition of the Troughton Dividing Engine (from the Science Museum, Kensington).

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall), at 8.—Prof. E. W. MacBride: The Inheritance of Mental Defects.

INSTITUTE OF METALS (London Local Section) and INSTITUTION OF BRITISH FOUNDRYMEN (at Institute of Marine Engineers, Inc.), at 8.—A. H. Munday: Some Foundry Problems.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Laboratory Meeting) (at London School of Tropical Medicine, Endsleigh Gardens), at 8.15.

FRIDAY, DECEMBER 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Dr. J. H. Jeans: Internal Motions in Spiral Nebulæ.—J. W. Gifford: Telescopic Triple Object Glass of High Relative Aperture.—J. S. Plaskett: The H and K Lines of Calcium in O-type Stars.—J. H. Reynolds: The Galactic Distribution of the Small Spiral and Spheroidal Nebulæ.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. A. H. Gibson and H. W. Baker: Exhaust-Valve and Cylinder-Head Temperatures in High-speed Petrol Engines.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. Bylander: L.C.C. Regulations for Steel Framed Buildings.

SATURDAY, DECEMBER 15.

BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at University College), at 3.15.—Miss H. M. Wells: A Note on the Psychological Significance of the Psycho-galvanic Reaction.—J. Kay: Visual Perceptual Tests.

PUBLIC LECTURES.

SATURDAY, DECEMBER 8.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. M. Delf: Sunlight and Life.

MONDAY, DECEMBER 10.

UNIVERSITY COLLEGE, at 5.30.—Prof. J. N. Bronsted: Some Chapters in the Recent Development of the Theory of Electrolytic Dissociation. (Succeeding Lectures on December 12 and 14.)

TUESDAY, DECEMBER 11.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—F. W. Twort: The Influence of Environment on the Life of Bacteria. (Succeeding Lectures on December 13, 17, 18, and 19.)

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Prof. D. Levaditi: Harben Lectures. (Succeeding Lectures on December 12 and 13.)

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Roots of Early Greek Philosophy: Ethical.

WEDNESDAY, DECEMBER 12.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—H. D. Herring: The Disposal of the Dead, with Special Reference to Cremation.

WESTFIELD COLLEGE (Hampstead), at 5.15.—Prof. Craigie: The Making of a Dictionary.

THURSDAY, DECEMBER 13.

KING'S COLLEGE, at 5.30.—Prof. Seton Watson: The Balkan States and Europe (League of Nations Union Lecture).

UNIVERSITY COLLEGE, at 5.30.—Miss M. A. Murray: Matrilineal Descent.

SATURDAY, DECEMBER 15.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: My Excavations in Malta.

SATURDAY, DECEMBER 15, 1923.

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The Problems of Pasteurisation.

IN the recent National Milk Conference convened by the National Clean Milk Society at the Guildhall, London, the problems of pasteurisation which formed the subject of articles in NATURE for January 27 and February 3 of this year were discussed. Pending the publication of fuller reports, it would appear that not much additional knowledge has been acquired from experimental or other investigations since those articles appeared. Opinion in the Conference differed widely as to the wisdom of pasteurisation of cows' milk under present conditions. Thus, Prof. H. E. Armstrong maintained that the Ministry of Agriculture and the Ministry of Health were working against the public interest by "patting pasteurisation on the back," while not forcing those who heated milk to tell the public what they had done with it. With the emphasis laid in this statement on the desirability of making it compulsory to declare the fact of pasteurisation and the temperature at which it is undertaken, when commercially practised, all hygienists will agree; but they would scarcely agree with the possible inference that regulated pasteurisation of milk is an evil. Other hygienists, like Profs. J. M. Beattie and H. R. Kenwood, favoured the practice of pasteurisation, the first named summarising his views in the words that pasteurisation, properly carried out, at a constant temperature somewhat higher than that at present in use, would bring about the destruction not only of tubercle bacilli but also of all other important pathogenic organisms.

The problem of pure milk is complicated by the desirability of cheap milk, and of increase in the per capita consumption of milk from about a quarter of a pint daily to at least three times this amount. Clean milk is necessarily expensive. The dangers from relatively uncleanly milk are reduced to a minimum by efficient pasteurisation. At the same time, improved sanitation of milk is extremely important even when pasteurisation is contemplated; while conversely, even clean milk produced under rigid conditions may occasionally cause disease unless it is pasteurised.

Neither method of approach to improvement can be neglected. Dairy and milk sanitation is important; but, for the efficient protection of the masses of population living in large cities, pasteurisation is necessary. This pasteurisation must, however, be efficient, and to be efficient it must be controlled and always declared, in order that the circumstances in which pasteurisation has been carried out may be inspected. Furthermore, more experimental work is needed on the various processes of pasteurisation as to their relative efficiency.

Facts and Fancies in Modern Anthropology.

(1) *The Evolution and Progress of Mankind.* By Prof. H. Klaatsch. Edited and Enlarged by Prof. A. Heilborn. Translated by J. McCabe. Pp. 316. (London: T. Fisher Unwin, Ltd., 1923.) 25*s*. net.

(2) *The Racial History of Man.* By Prof. R. B. Dixon. Pp. xvi+583+44 plates. (New York and London: Charles Scribner's Sons, 1923.) 25*s*. net.

(3) *Ancient Man in Britain.* By D. A. Mackenzie. Pp. xv+257+16 plates. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1922.) 12*s*. 6*d*. net.

THE three anthropologists the titles of whose works are given above have approached problems relating to the origin of human races and of their civilisations by totally different routes, but all of them have this in common: they have reached their respective destinations by giving their imaginations the freest of reins. No one who examines the frontispiece of the late Prof. Hermann Klaatsch's book—his death in 1916 at the age of fifty-two robbed German science of one of its boldest exponents—would readily associate his burly body and prize-ring face with fanciful speculations regarding man's evolution. Nor do we expect Prof. Roland B. Dixon, who holds the chair of anthropology at Harvard University, to use a few measurements of the skull as fairy wands wherewith to rear wonderful anthropological castles in the air of long past ages. His castles, we fear, like those which children build on the sands, are doomed to disappear as the incoming tide of reason flows over them—but of this, more anon. There can be no doubt that Dr. Donald A. Mackenzie's imagination is a part of himself; he is a student of Celtic literature, of Egyptian mythology, of primitive folk-lore. He has that invaluable quality, denied to men of strictly scientific training, of entering the primitive human mind, seeing the world through its eyes, and understanding its modes of reasoning. He has used his gifts and training in drawing a word-picture of ancient man in Britain and the sort of life he lived.

(1) Prof. Klaatsch's book, finished and edited by his friend, Prof. A. Heilborn, and translated into English by Mr. Joseph McCabe, contains a popular account of the opinions he had formed relating to the origin of man and his mind; to the beginnings of his speech, his morals, his weapons, his home, and his societies. However much one may resent the brusque way in which this German professor has brushed aside the facts and opinions of most of his contemporaries, and the dogmatic way in which he has made assertion serve the place of reason, yet his writings demand and deserve our serious consideration. Klaatsch was trained under Gegenbaur and became his assistant. He had been assistant to Waldeyer, and from his boyhood had been a close student of Darwin and of Huxley. He came into European prominence towards the end of last century, when the late Prof. Schwalbe of Strasbourg was giving Neanderthal man the place originally assigned to him by Dr. William King—that of a quite distinct species of humanity, sharply marked off from all living varieties of mankind.

Klaatsch made the fossil remains of man—particularly of Neanderthal man—his special study, and published long and somewhat prolix monographs on them. Then he took up the study of ancient stone implements, and proceeded to sites in Belgium and England to learn at first hand their nature and antiquity. To help him to interpret the ways of ancient man in Europe he set out in 1904 to live in contact with the most primitive of living races—the aborigines of Australia. He never ceased to extol the fine gentlemanly qualities of the aboriginal Australian; he persuaded himself that he detected Indo-Germanic elements in the aborigines' speech, and took a particular delight in claiming the Australian native as the ancestral type of the European! Much of the book here reviewed is based on experience he gained during the three years spent in Australia. He returned in 1907 to fill the full chair of anatomy and anthropology in the University of Breslau, and to rush about the continent of Europe to see the latest find of fossil man. He was soon in the sand-pit of Mauer when the Heidelberg jaw was found; he was in the Dordogne when his Swiss friend, Hauser, uncovered fossil remains of man at Le Moustier and at Combe Capelle; he went to Agram to see the remains discovered at Krapina. With such a record we cannot turn down lightly the opinions of this robust and industrious German professor.

Prof. Klaatsch was a vigorous exponent of evolution, but as regards the origin of human races he held certain peculiar opinions, to which he first gave expression after making a detailed examination of the fossil remains of Neanderthal man. He found that this extinct species of mankind shared many minor characters with the gorilla, and to account for the common heritage he framed the conception that they were co-descendants from an ancestral stock of ape-men. For reasons which he never made quite clear, he linked the Negro race on to the Gorilla-Neanderthal stem. He further supposed, without a scrap of evidence, that these ancestral ape-men were in our modern sense more man-like than ape-like, and while the gorilla fell away towards apedom as evolution went on, his more fortunate cousins—the Negro and Neanderthal man—proceeded towards their higher goals. He returned to the discarded idea of

Lord Monboddo, that apes were degenerate men—or, to use Klaatsch's own expression, they represent "abortive attempts at human evolution." On the other hand, the races of Europe, Asia, and Australia, although they, too, had arisen from the same ancestral stock of ape-men, had taken a totally different route to reach their humanity, having been accompanied in part of their evolutionary journey by the ancestry of the orang—another abortive attempt at man-production. Klaatsch himself was uncertain as to which human race had its past twined with the ancestry of the chimpanzee, but some of his followers have provided its human counterpart and also one for the gibbon. Once one enters the topsy-turvy evolutionary mill of the polygenist, there is no calling a halt: the extinct forms of anthropoid apes will also require human counterparts if Klaatsch's views are sound; and as geologists will provide scores of them in the course of time, the fertile imagination of the polygenist must look forward to a busy and perplexing future.

What should we say if any one were solemnly to assure us that Spanish and Italian were speeches of diverse origin, but that as they evolved they had come to resemble each other? Those who maintain that the close structural resemblances between the Negro and the European are due to convergence, as Klaatsch did, take up an equally untenable position.[1]

It must not be thought that the whole of Prof. Klaatsch's book is given over to a discussion of the evolution of man's body and brain. Far from it: a chapter is devoted to the evolution of weapons and to the discovery of fire and the results which followed from that discovery. One result was that primitive and hairy man, sleeping by the fires he succeeded in kindling and feeding, became nude. In another chapter is given an account of the origin of clothes; Prof. Klaatsch stoutly maintained that clothes were worn at first purely as ornaments; he cites ladies' underwear as proof of his contention, but appears to have forgotten that the orang and chimpanzee find out for themselves that an old blanket or a newspaper can serve more than an ornamental purpose. Chapters are devoted to the evolution of speech, of society, of religion, of the home, and of motherhood.

All departments of anthropology are dealt with; in every section the author sets down in clear, unmistakable terms the conclusions he has reached regarding the matters dealt with in his pages. It is the author's courage rather than his judgment which is to be commended. In brief, this book of Prof. Klaatsch's is of value, not because it represents a weighty contribution to anthropology, but because it gives in a readable form the opinions held by an outstanding personality concerning the manner in which man has come by his present place in the world.

(2) Prof. Klaatsch was a polygenist; Prof. Roland B. Dixon is also a polygenist, but of a new kind. The title which he has given his book, "The Racial History of Man," seems to convey the impression that we are to be told how the Negro, the Chinaman, the European, and other well-differentiated races of mankind came into existence. His publishers have given his book all the appearance in paper, type, and binding which marks a standard work. Prof. Dixon's book is in reality a treatise on polygeny; of that he is in no doubt, for he writes:

"The acceptance of such an hypothesis, of the theory that the existing varieties of man are to be explained, not as derived by differentiation from a single ancestral form, but as developed by amalgamation of the descendants of several quite discrete types, places us squarely in the ranks of the long discredited polygenists" (p. 503).

There is no doubt that Prof. Dixon has put himself in his proper category, and we want to know how he came to fall into this position. He, like Prof. Klaatsch, is a thorough-going evolutionist: he is convinced that, in its early evolutionary history, man's ancestral stock progressed in quite an orthodox manner; it diverged, forming many branches, representatives of some of which have been found in a fossilised form in Java and Piltdown, etc. But there came a time—the date is not explicitly stated—when only eight branches—or human types—were left. We are told the names of these. There was (1) the *proto-Australoid*, cradled somewhere round the Indian Ocean; (2) the *proto-Negroid*, whose home was in Africa; (3) the *Mediterranean*, living in Asia to the east of the Mediterranean; (4) the *Caspian*—a new name for our old friend the Caucasian—living in Asia, north and east of the Caspian; (5) the *Mongoloid*, and (6) the *Palæ-Alpine*, neighbours on the central plateau of Asia; (7) the *Ural*, of uncertain nativity, but placed in the meantime in Eastern Russia; (8) the *Alpine*, also a native of Asia. For some reason, which the author does not mention, these eight primitive types of man, living in and native to diverse regions of Africa and Asia, began a great game, which can only be described as that of "anthropological chairs." They all started moving round the world, into each other's countries, and mixing in the most promiscuous way. Out of this old-world game came our modern races—Negro, Negrito, Australian aborigine, Europeans of all sorts, Egyptians, Chinamen, Red Indians, and Lapps. The difference between one modern race and another wholly depends, according to Prof. Dixon, on the proportion in which the eight original races were

[1] Klaatsch's theory was discussed at some length in the pages of NATURE of Nov. 24, 1910 (Vol. 85, p. 119).

employed in their compounding. The Eskimo, one of the most distinctive races of mankind, and marked by unmistakable Mongolian features, has nothing of the Mongol in him, according to Prof. Dixon, but is compounded from the types which make up the peoples of Western Europe, namely, the Mediterranean, Caspian, and Ural types. To the fashioning of Englishmen all the original eight primary types of mankind have been employed, including, of course, the Mongol, the proto-Negroid, and the proto-Australian.

Prof. Dixon came by his discovery in the simplest way possible. To recognise members of his original types, in any race or people whatsoever, he employed three measurements of the skull, its length, width, and height, and two of the nose, its height and width. If the head, according to his standard, was long and low and the nose broad, then the individual with such proportions, no matter what the colour of the skin, texture of the hair, proportion of the body, and general appearance might be, was a proto-Australoid; but if the nose was narrow, this alters the case: the individual is a Mediterranean. But if the head was long and high and the nose narrow, then the individual possessing such proportions must be placed in another category, that of the Caspian archetype. In discussing the distribution of the proto-Australoid type in Europe, Prof. Dixon proves its presence in Germany in neolithic times by citing two skulls of that date with particularly wide noses. In his table (p. 477) the width of the nose is given as 23 mm., the height as 48 mm., and the proportion of width to height as 57·9 per cent. But if the reader will work the sum out, he or she will find it is not 57·9 but 47·9 per cent. On this slip in his arithmetic Prof. Dixon builds his hypothesis of a proto-Australoid stock in neolithic Europe. In other cases his arithmetic may be right, but his methods and inferences have just as little foundation in fact as in the former case. Why, every anthropologist knows of families where one brother, on Prof. Dixon's scale, would be a proto-Negroid, another a Caspian, another a Mediterranean or Ural, while among the sisters of the same family might be found representatives of his remaining types.

To make quite clear the methods pursued by the professor of anthropology in Harvard University, let us suppose that the history of the various makes and types of motor-car is unknown, and that Prof. Dixon has undertaken to discover how the various types have come into existence. If he applied the method which he has employed to unravel the history of human types, he would measure the length, breadth, and height of the body of each type of car and the width and height of the bonnet, and with these measurements to work on would deduce the history of each make of car. Essential points concerning the engine, the gearing, steering, the system of ventilation and lubrication, and all the essential details which go to the proper working of a car, are to be passed unnoted. When the matter is put in this way, even those who regard cranial measurements as sacrosanct will understand the value to be attached to Prof. Dixon's account of the evolution of human races.

(3) In Dr. Donald A. Mackenzie's pages we have Western Europe pictured as a corridor leading from Egypt, or some adjacent part of Africa or Asia, to Britain. In ancient times there passed along this corridor a continuous procession of various types of men, each carrying its peculiar customs and beliefs. The Cromagnon people, in Dr. Mackenzie's account, head the procession; they came from east of the Nile, and brought to Europe and to England the religious beliefs of their native land. They were followed by the "Solutreans," who, we are told, came from about Somaliland. After them came the "Magdalenians," the "Azilians," and the "Tardenoisians." The Magdalenians, we are informed, were really Cromagnon people. The only folk who did not come the usual way and from the usual source were the "Maglemosians"; they came from Siberia to the Baltic, and brought the dog to Europe; they were blonds of the Nordic type. So far as the writer knows, only one fragmentary skull of the Baltic kitchen-midden people (the Maglemosians) has so far been found; we know nothing of a Nordic people in Siberia in early neolithic times; there are not half-a-dozen human skeletons, or fragments of skeletons, which can be ascribed to people who made the Azilian and Tardenoisian types of weapons or implements. We really know nothing of these people whom Dr. Mackenzie has made to move so briskly towards Britain in ancient times.

Perhaps it will be fairest to let him speak for himself:

"For a long period, extending over many centuries, the migration 'stream' from the continent appears to have been continuously flowing. The carriers of neolithic culture were in the main Iberians of Mediterranean racial type—the descendants of the Azilian-Tardenoisian peoples who used bows and arrows, and broke up the Magdalenian civilisation of Cromagnon man in Western and Central Europe. This race appears to have been characterised in north and north-east Africa. 'So striking,' writes Prof. Elliot Smith, 'is the family likeness between the early neolithic people of the British Isles and the Mediterranean and the bulk of the population, both ancient and modern, of Egypt and East Africa, that the description of the bones of an early Briton of that remote epoch might apply in all essential details to an inhabitant of Somaliland'" (p. 126).

For the latter part of his statement Dr. Mackenzie

has the highest authority, but, so far, the writer has heard of no one who has made and published a detailed comparison between the bones of neolithic Britons and those of modern Somalis and Egyptians. It is highly desirable that an investigation of this kind should be made, for it is difficult to believe that there is any degree of Somali blood in modern England.

ARTHUR KEITH.

The Orders of Insects.

Manual of Entomology: with Special Reference to Economic Entomology. By Prof. H. Maxwell Lefroy. Pp. xvi + 541 + 4 plates. (London: E. Arnold and Co., 1923.) 35*s.* net.

THE classification of insects has passed through many changes, and most of the systems proposed have been primarily based upon characters afforded by the wings, mouth-parts, and metamorphoses. During the last fifteen years entomology has suffered from an over-exercise of the analytic faculty on the part of morphologists. One result of their activities is seen in the increasing number of subdivisions of the class Insecta, and some eminent authorities even dismember the latter as a whole. The tendency is to emphasise differences rather than the features which groups reveal in common. In some cases the same morphological characters in different orders are not credited with proportional values. The result, as might be anticipated, is a condition of instability with no very clear conception of what is to be regarded as an order and what is not.

The foundations of the modern classification of insects were laid by Brauer in 1885. He recognised the fundamental division of the Insecta into the two sub-classes Apterygogenea (Apterygota) and Pterygogenea (Pterygota)—members of the former being primitively apterous and those of the latter winged, or in some cases secondarily apterous. Brauer also did much towards dividing the old assemblage Neuroptera into separate sections, each of ordinal value. In 1899 Sharp established a system partly modelled upon that of Brauer, and he introduced the terms Exopterygota and Endopterygota, in order to discriminate between those orders in which the wings develop outside the body, and those in which they remain internal until pupation. He further introduced the term Anapterygota to include those apterous orders which have, presumably, become secondarily wingless. This latter step, however, has the disadvantage of bringing together distantly related groups.

In 1904 Shipley adopted Sharp's system almost in its entirety, but proposed certain new ordinal names with the double object of doing away with the use of family designations for ordinal purposes, and of introducing a system in which the suffix "ptera" is extended to all orders. In the same year Börner proposed a system which recognised the same orders as Shipley (although not necessarily under the same names), with the exception that he adopted a threefold division of the Apterygota, and revived the ordinal name Corrodentia for the Psocoptera and Mallophaga. Four years later Handlirsch launched a revolutionary scheme: he no longer retained the Insecta as a primary division of the Arthropoda, and his system involved their dissolution into four classes comprising no less than 34 separate orders. In America he has found support from Brues and Melander (1915), who added the more recently discovered orders Protura and Zoraptera and, at the same time, elevated the family Grylloblattidæ to ordinal rank, thus recognising altogether 37 orders. Berlese, on the other hand, in his encyclopædic treatise "Gli Insetti" reverts to a simplified taxonomy and diagnoses but nine orders. In a few words, it may be said that centres of disruption exist in the orders Orthoptera, Corrodentia, and Neuroptera as defined by Brauer. Once a condition of equilibrium is attained with respect to these three groups we may be on the high road to something approaching unanimity.

Prof. Lefroy's book is essentially one on the orders of insects. In the preface it is mentioned that the book is based "upon the lectures given as the second of three parts of a course occupying one year of a full training in entomology." This apparently accounts for the absence of any general chapters on structure, biology, or development. On the whole, a very reasonable compromise is made between the radical tendencies of Handlirsch and undue conservatism, and some 26 orders are separately treated more or less in detail. The book is written for the student of applied entomology, and its object is to teach him how to recognise an insect in the field, to determine its sex, to learn about its habits and the methods of control, and to familiarise him with some of the more important monographs or catalogues which provide references to the literature.

The conception of the book is a good one. In carrying it out Prof. Lefroy assumes that the student is working with a collection of specimens which he can handle—illustrations are not very much believed in—and has access to the "Zoological Record," "Genera Insectorum" and the *Review of Applied Entomology* for further information. References consequently do not, as a rule, include the names of the journals concerned, and sometimes only comprise the names of the authors, along with the dates of their publications. This method has very obvious difficulties, and, although

it doubtlessly works all right in Prof. Lefroy's own department, a restriction is inevitably placed on the circle of those who might use the volume—particularly outside the British Isles. Anyway, this is the plan upon which the student is intended to proceed.

In the preparation of the volume the services of eight past or present students of the Imperial College have been enlisted—a certain number of orders having been allotted to each. The necessary information having been collected and written up, the whole was then, presumably, sifted and edited by Prof. Lefroy. This unorthodox method has its pitfalls. The various sections, each of which is devoted to a separate order, are of rather unequal merit—as might be expected—the one devoted to the Neuroptera being probably the best. Also, the book contains a number of misprints which suggest hurried proof-correcting, and contains errors which, if repeated in an examination paper, would tell considerably against a candidate. For example, on p. 10 the extra spiracles of Japyx are stated to be on the prothorax: on p. 41 the cervical sclerites are mentioned as articulating the thorax to the abdomen: on p. 87 the mandibles of the nasute caste of termites are stated to form a kind of beak through which a secretion can be exuded at will: on p. 457 Glossina is credited with dropping its larvæ one at a time while in flight.

On the other hand, almost all the families of insects are mentioned, and most of them treated separately, which, in itself, is quite an achievement: in some cases even the sub-families are enumerated and commented on. The book also contains a good deal of information not otherwise very accessible. It is admirably printed, but the price seems rather high. The four half-tone plates are excellent, and the text-figures, for the most part, serve their general purpose. A. D. I.

Photographic Science.

Photography as a Scientific Instrument. A Collective Work by A. E. Conrady, Charles R. Davidson, Charles R. Gibson, W. B. Hislop, F. C. V. Laws, J. H. G. Monypenny, Dr. H. Moss, Arthur S. Newman, Dr. Geo. H. Rodman, Dr. S. E. Sheppard, W. L. F. Wastell, Wilfrid Mark Webb, Col. H. S. L. Winterbotham. (Applied Physics Series.) Pp. vii + 549 + 21 plates. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1923.) 30*s*. net.

OWING to the enormous advances which have been made in the various branches of science, recent years have seen the publication of numerous monographs written by specialists in one particular domain. Chemistry and physics have been well catered for in this respect, but, at all events in Great Britain, there has been no series of monographs dealing with photography, a subject which may be considered as belonging to physical chemistry. The present book, to some extent, supplies this want. It consists of fourteen chapters written by thirteen different men, each of whom is an acknowledged authority on the subject about which he writes. Although it would not be correct to describe the various chapters as monographs, since a complete description of the particular branch under consideration is not attempted, yet in each one is brought together a mass of knowledge which has hitherto been scattered far and wide in the literature, or has remained embodied as "experience" with individual workers.

The first four chapters treat of the history, optics, and chemical and physical processes of photography: they may be considered as dealing with the more purely scientific side, whilst the remaining ten chapters treat of the application of the art in various branches of science and technology.

When dealing with a book of this kind the reviewer is necessarily subject to limitations: he cannot have a knowledge of all the subjects treated, and consequently is attracted by some chapters rather than others. From the purely scientific point of view, those due to Prof. Conrady and Dr. Sheppard are especially worthy of mention. The former bases his treatment of the photographic lens system on the Abbe form of the general theory, and deals with it from the point of view of the user rather than that of the designer and computer. The properties of lens systems, and the various classes of aberrations to which lens systems are subject, are treated in a surprisingly simple manner. The practical photographer will be especially interested in "The Experimental Determination of the Constants for any Lens System," and with the explanation of depth of focus, ghost images, flare spots, etc. He will also find that a perfect lens system is impossible, the best obtainable being the result of a large number of compromises leaving always small residuals of aberration. Such knowledge is important to the purchaser, who will not then expect too much from the makers or sellers, who are generally silent on such points.

Since all the applications of photography depend on having the necessary sensitive material with which to work, it is natural that Dr. Sheppard's chapter is the longest in the book. The author has been, so to speak, "born and bred" in the subject, and, possibly because of this, in some of his publications he has been apt to forget that his readers have not the same acquaintance with the subject as he has. In this chapter, however, Dr. Sheppard has not fallen into this error, and the reviewer does not know of any other account which covers the facts so clearly and lucidly. One failing,

however, Dr. Sheppard does not seem able to overcome. Chemical equations seem to be beneath his notice; in particular, the equation representing the reaction between ferrous sulphate and silver nitrate (p. 140) contains so many errors that one cannot fail to notice them.

The photographic methods used in astronomical photography are described by C. R. Davidson, and Dr. Moss gives a valuable selection of examples of the application of photography to physical investigations. "Photomicrography" is covered in two chapters, J. H. G. Monypenny dealing with its application in metallurgical and engineering research, whilst Dr. Rodman, in a more popular manner, describes its application in histology, bacteriology, and pathology. There is necessarily some duplication in these chapters, and, as is not to be wondered at, differences of opinion. Similar remarks as to overlapping hold with respect to the chapters on "Photographic Surveying," by Col. Winterbotham, and on "Aeronautical Photography," by Major Laws. The differences in view-point obtained are, however, all the more instructive.

Mr. Wastell describes the various colour processes, from that of Lippmann to the latest form of kinematography in colour; and Mr. Hislop deals with the application of photography to various printing processes in monochrome and in colour. The last two chapters deal with the "Technics of Kinematography" and "The Camera as Witness and Detective."

The book is a valuable one, and should be of interest not only to specialists in photography, but also to the public in general. T. S. P.

Our Bookshelf.

The British Pharmaceutical Codex, 1923: an Imperial Dispensatory for the Use of Medical Practitioners and Pharmacists. (Published by direction of the Council of the Pharmaceutical Society of Great Britain.) New and revised edition. Pp. xx + 1669. (London: The Pharmaceutical Press, 1923.) 30*s*. net.

THE British Pharmaceutical Codex was compiled by a committee of experts, working under the direction of the Council of the Pharmaceutical Society, and was intended to afford to pharmacists and physicians a ready means of obtaining trustworthy information concerning drugs and medicinal preparations in general use throughout the British Empire. It has fulfilled its purpose well. Works of this type, however, quickly lose their value, and, notwithstanding the publication of supplements in 1915 and 1922, a new issue was overdue. The text of the book bears on every page evidence of thorough and careful revision, and it is now well abreast of pharmaceutical and medical practice. Among the new monographs that attract attention is that on acriflavine. Here the constitution and preparation of this important antiseptic are explained, and a full page is devoted to an exposition of its advantages in medical and surgical treatment, the form in which it is best prescribed, and the synonymy of its derivatives, euflavine, homoflavine, and proflavine. Chloramine-T and the chlorinated antiseptics, eusol, Dakin's solution, and Daufresne's solution, are similarly discussed. The thoroughness evident in these monographs characterises the whole work, and it is just this that makes the Codex so valuable and trustworthy. Under the heading "Curationes" a general description of surgical dressings and the methods by which they may be tested is given; it is curious to note that the lint of the Codex is composed entirely of cotton, whereas the presence of cotton was formerly considered objectionable on account of its supposed irritating nature. Insulin, thyroxin, and other drugs of very recent origin find a place in the work. The list of test solutions and microscopical stains is a very restricted one, and scarcely justifies its title. The whole work is remarkably free from errors, and the committee entrusted with its preparation may be congratulated on the success of their efforts. It is to be hoped that the Council will not, from motives of economy, unduly delay the appearance of a new edition, so that the book may always be kept well up-to-date.

Vom Gleitflug zum Segelflug: Flugstudien auf Grund zahlreicher Versuche und Messungen. Von Gustav Lilienthal. (Volckmanns Bibliothek für Flugwesen, Band 15.) Pp. 159. (Berlin-Charlottenburg: C. J. E. Volckmann Nachf. G.m.b.H., 1923.) 2.50 marks.

"EINE Kritik meiner Arbeiten nur vom grünen Tisch aus, ohne meine Experimente und Messungen nachzuprüfen, lehne ich von vornherein ab." This is the beginning of the last paragraph in the book by Herr Gustav Lilienthal, the brother and collaborator of the famous Otto Lilienthal. He is led to take up this uncompromising attitude because, he claims, the results of his lengthy and laborious measurements have already been criticised in a manner suggesting that they have not been properly examined and understood.

Herr Lilienthal discusses the old problem of soaring or sailing flight. He maintains that the present form of aeroplane is due to the misdirection of effort caused by the War, when aeroplanes were required at once and in as large numbers as possible, with the result that the type then known became standardised for all purposes and all nations. The author's view is that the modern aeroplane, in which the wings do the sustaining while an engine is used for propelling, is an imitation of the beetle rather than of the bird. He hopes that the effect of the revival of gliding will be to cause the aeroplane to approximate more to the bird form, with the wings supplying the propulsion as well as the sustentation.

Meanwhile, Herr Lilienthal discusses how the sailing flight of certain birds is possible. He claims to have established experimentally that the wind supplies the work required for sailing flight, by means of its property of making bodies suspended in it turn through about 4° upwards. Further, the camber in a bird's wing produces an eddy below the wing, with the result that the work supplied by the wing is used for both sustentation and propulsion. It is difficult to see why

a horizontal wind should produce the 4° turn which Herr Lilienthal claims to have measured, but it is a suggestion worthy of consideration, and one that may lead to interesting developments. S. B.

Les Principes de la physique. Par Dr. Norman R. Campbell. Traduit et adapté en Français par Mme. A. M. Pébellier. (Nouvelle Collection Scientifique.) Pp. xix + 200. (Paris : Félix Alcan, 1923.) 8 francs.

A TRANSLATION into French of Dr. N. R. Campbell's book entitled "Physics, The Elements," was suggested to the author by M. Émile Borel, who had been called upon for a notice of the volume in the *Revue philosophique*. But the length of the original imposed the necessity for considerable abbreviation ; one-third only of this smaller book is a textual translation, the rest is an abstract, the developments of several pages being sometimes reduced to a few lines. Mme. Pébellier has carried out both the paraphrase and the translation, and her difficult task seems to have been performed most efficiently. The book is rendered more interesting, especially to the English reader, by the preface contributed by M. Borel. He emphasises the great importance of the treatise, arising from the fact that the author is an experimental physicist, and moreover an English physicist. Experimental and theoretical work correspond to different forms of activity, and perhaps to different forms of thought. Continental physicists, whether they are French, German, or Italian, are perhaps less purely physicists than the English. It may at least be affirmed that the latter have certain particular qualities, qualities which sometimes shock the savant of the Continent but in practice produce remarkable results. M. Borel proceeds with an interesting discussion of the language of physics, which he regards as intermediate between the exact language of mathematics and the vaguer language of the vulgar tongue, in which words have only a *statistical* definition. In its new form Dr. Campbell's work should appeal to a wide circle of readers.

The Poulsen Arc Generator. By C. F. Elwell. Pp. 192. (London : Ernest Benn, Ltd., 1923.) 18*s*. net.

As there are more than 20,000 kilowatts of arc transmitters in use to-day, it is highly probable that they will remain in use for many years to come. The British Post Office adopted a 250 kw. Elwell-Poulsen arc generator for the first link of the Imperial Wireless Chain connecting Leafield with Cairo. These two stations are now in operation at two-thirds of the cable rate. The same type of generator is also used at Northolt for communication with the Continent. The Dutch Government is installing a 2400 kw. Poulsen arc, the largest in the world, in Java, to enable it to communicate directly with its colonies. As the author points out, it is the one good system which is not covered by a multitude of patents thought by many to be employed to dictate the terms and conditions under which the other systems may be used. The book begins with a historical introduction, due stress being laid on Duddell's discovery of the musical arc. The arc generators are then described, and finally clear descriptions are given of the methods and apparatus used for signalling and the application of the generator to radio-telephony.

Clinical Laboratory Methods. By Prof. R. L. Haden. Pp. 294 + 5 plates. (London : H. Kimpton, 1923.) 18*s*. net.

THE author of this book has adhered strictly to his object of presenting methods of carrying out clinical laboratory work without in any way discussing the interpretation of the results. The volume is therefore essentially a manual for the laboratory worker. The various tests are described briefly, but with attention to every practical detail, and references to original articles are provided with most of the descriptions. The author has limited himself as a rule to one method for each quantitative estimation, apparently with the rather narrow view that one method is suitable in all circumstances. The examination of gastric contents differs considerably from the examination generally carried out in Great Britain, and no consideration is given to the fractional test meal. The illustrations, with the exception of those of blood cells, are very good. Making allowance for slight differences in terminology, the clinical pathologist will find in this book a clear description of the laboratory methods in general use.

Textile Chemistry : an Introduction to the Chemistry of the Cotton Industry. By F. J. Cooper. Pp. ix + 235. (London : Methuen and Co., Ltd., 1923.) 10*s*. 6*d*. net.

MR. COOPER'S book covers a good deal of ground in a brief but clear fashion. It reads more like a note-book than a text-book, but is obviously the work of a number of years of teaching, and should be useful to students in technical schools, for whom it is intended. Besides the elementary chemistry which serves as an introduction, the author discusses its applications to the textile industry, and among other things the natural fibres, the chemistry of coal, oils, industrial waters, sizes, bleaching, dyeing, and mercerising. Those engaged in teaching the subject will find the book useful and helpful. There are a few minor inaccuracies : a "base" need not contain a metal (p. 66) ; nitric oxide is not absorbed by sulphuric acid (p. 69). The descriptions of experiments are not always adequate, and some of them (as that shown in fig. 119) can scarcely have been tried successfully.

Radio Telegraphy and Telephony. By Prof. E. W. Marchant. Pp. ix + 137. (Liverpool : University Press of Liverpool, Ltd. ; London : Hodder and Stoughton, Ltd., 1923.) 6*s*. net.

A VERY large number of books on radio telegraphy and radio telephony have recently been published. Many are of little use to the general scientific reader because they are too elementary ; others fail because they are too technical, the authors revelling in technical terms which are in general very vaguely defined. Prof. Marchant seems to have hit on the happy mean in this little volume. The science is accurate, the descriptions are good, and the information is up-to-date. To make assurance doubly sure the author has added a glossary giving good definitions of the technical words used in the text. This book can be recommended to the reader who wants to understand the principles utilised in radio telephony, broadcasting, and directional radio signalling.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Some New Commensals in the Plymouth District.

WHILE collecting by digging on the shore at Millbay, Salcombe, in April this year, I found three consecutive pairs of Synapta and a polynoid worm living together, and at the same time three distinct associations of the brittle star, *Ophiocnida brachiata*, and a small mollusc. These finds led to five later

FIG. 1.—The brittle star, *Ophiocnida brachiata*, with the polynoid, *Harmothoë lunulata*, clasping and curving over the disc, opposite the arrow head and alongside the projecting arm which is broken off short; and the mollusc (M), *Montacuta bidentata*: three animals living associated together buried in muddy sand at Salcombe. $\times$ *ca.* $\frac{3}{2}$. (From a photograph by Mr. R. S. Clark.)

monthly visits during the best spring tides, and resulted in the observations given below.

The polynoid, *Harmothoë lunulata*, was found in muddy sand at Salcombe on adjacent beds with six different animals belonging to two different phyla and four different classes, but the more interesting point is that the size of the polynoids forms on the whole an increasing series approximately as follows: *Harmothoë lunulata*, a few to 10 mm., with *Ophiocnida brachiata*, and curved round the disc or over the mouth (Fig. 1); *H. lunulata* (var. *synaptæ* St. Joseph), 15 to 20 mm., with *Synapta inhærens* and *S. digitata*, and also occasionally with *Phascolosoma pellucidum*. On the same beds occur larger specimens of a polynoid somewhat different in general appearance from the small *Harmothoë lunulata* just mentioned, but they appear to be merely later-growth stages of the same species, and agree generally with the var. *nigra*, Alæjös. Specimens of this form about 20 to 30 mm. were taken with *Phascolosoma vulgare*, and of 35 to 50 mm. with *Amphitrite Edwardsi*. Further work will be required to put this last observation on a secure basis, but the animals can only be obtained by special search in small numbers at considerable intervals of time. There is little doubt, however, that this species of Harmothoë at Salcombe starts life commensally with Ophiocnida, and changes its mate as it grows bigger and requires more accommodation in the burrow provided by the messmate, until it finally consorts with polychætes up to 30 cm. long, such as *Amphitrite Edwardsi*.

Harmothoë lunulata was also taken at the mouth of the River Yealm with *Synapta inhærens*, and will no doubt later be found in the same association in Plymouth Sound.

During the same expeditions the almost constant association of the mollusc *Montacuta bidentata* [1] with *Ophiocnida brachiata* was confirmed. The mollusc in this case is frequently found in numbers just below or above the disc, and occasionally under an arm in company with *Harmothoë lunulata* young. The same mollusc was taken also but less frequently with the Gephyrean, *Phascolosoma pellucidum*, and occasionally with Nereis. With this Gephyrean, however, was found fairly constantly the messmate *Lepton Clarkiæ*,[1] which was fairly frequently present in groups of 4 to 7, and sometimes attached to the skin of the blood-worm.

On both shores at Salcombe another Harmothoë sp. B, not yet identified, was taken in tubes with one, and not in tubes with other species of Nereis. The same species was taken by careful work also in Rum Bay, Plymouth Sound, alongside or under the tentacles of *Amphitrite gracilis*, *Polycirrus aurantiacus*, and another species of Polycirrus, and at the same time *Harmothoë marphysæ* was rediscovered with *Marphysa sanguinea* in Plymouth Sound after a long lapse of years. The same Harmothoë sp. B was also taken with Nereis in beds at the River Yealm. It is an interesting fact that Sir Ray Lankester took a similar polynoid under the tentacles and in the tubes of *Terebella* (*Polymnia*) *nebulosa* at Herne so long ago as 1865.

The frequency with which the associates mentioned above occurred apart from each other was noted during the collecting work, and found to be low except in the case of *Phascolosoma pellucidum*, which occurs in thousands in a few square yards of ground.

In none of these cases of association or commensalism can a reason for it be asserted with any certainty. The frequent occurrence of polynoids, however, at the bases of the tentacles of polychæte commensals, as Polycirrus, or in or near the grooves of other polychætes, as Amphitrite, Nereis, Chætopterus, or the grooves of Ophiocnida, suggests the pilfering or scavenging of food-material. In the cases of Montacuta and Lepton it is clear that food-material is abundant in the burrows they inhabit, as their shells are often covered with Polyzoan polyps, and in addition various Foraminifera are not uncommon in the mouths or in the region of the burrows.

Indeed, the variety of associates of some commensals suggests, on the other hand, that an inhabited burrow may be simply and mainly a harbour of refuge, which is used so frequently that the inhabitants learn to know and tolerate each other, while at the same time not necessarily depending directly in any particular way on each other for food.

J. H. ORTON.

The Laboratory, The Hoe, Plymouth,
November 8.

[1] I am much indebted to Mr. R. Winckworth for the determination of these species.

Conductivities of Aqueous Salt Solutions.

IN the course of an investigation carried out during the last two years on the transference numbers and conductivities of certain aqueous salt solutions, we have come across a simple relation which appears to us of interest and importance.

The specific conductivity of an electrolyte (κ) as usually measured, refers to one *centimetre cube* of the solution. We found it desirable, when working with concentrated solutions, to compare figures given by volumes of electrolyte containing always *one gram of water*. If the solution in question contain x grams of salt per thousand grams of water, and is of density d, then the volume of solution containing one gram of water is $\frac{1000+x}{1000d}$. Multiplying this term by κ, we obtain a magnitude which we will denote by κ', which is the conductivity between electrodes one cm. apart of an amount of the solution containing one gram of water. At high concentrations, the viscosity of the solution is a factor which cannot be neglected. Making the simplest assumption, *i.e.* that conductivity and fluidity are proportional, we arrive at a corrected conductivity,

$$\kappa' \text{ corr.} = \frac{1000+x}{1000d}\kappa\eta.$$

Multiply by 1000, and we have the conductivity under the same conditions due to an amount of solution containing 1000 grams of water. If now this be plotted against x/M or the weight molar concentration (mols per thousand grams of water), the result is a curve which, in the cases of potassium, sodium, and lithium chlorides, becomes nearly linear after x/M has exceeded 0·5-1, and remains so up to the limit to which we have so far carried our measurements ($x/M = 3$ to 5, depending on the electrolyte). We have plotted the conductivity, density, and viscosity data of other observers for certain other solutions, and have obtained similar results.

Expressed verbally—if a thousand grams of water are put between electrodes one cm. apart and one of the salts in question gradually added, the increase in conductance of the cell (corrected for viscosity change) brought about by dissolving, say, an extra one-tenth gram equivalent of salt is nearly independent of the concentration of the solution when a certain limit of concentration has been exceeded. The slope of the curve is given by

$$\frac{(1000+x)\kappa\eta}{d\frac{x}{M}}.$$

A curve of the same slope is got if the molar fraction of the salt in the solution is plotted against the conductance (corrected for viscosity and measured between electrodes one cm. apart) of a mol of solution: that is, within the limits mentioned, the corrected conductance of a solution is practically proportional to the ratio salt molecules/total molecules.

This relation, obtained by considering, not, as is customary, the conductance of a fixed weight of salt to which increasing amounts of water are added, but the conductance of a fixed weight of water to which increasing amounts of salt are added, would appear to have considerable implications in several directions for the theory of strong electrolytes. These will be considered, and the data more fully presented, elsewhere.

We have written this preliminary note as a result of reading recently a paper published some months back by Linde (*Zeitsch. Elektroch.* 29, 163, 1923) and not previously noticed, as its title did not indicate any particular bearing on our work. In this paper the author has plotted $\kappa\eta$ against $\frac{100x}{1000+x}$ (*i.e.* the specific conductivity corrected for viscosity against the weight percentage of the salt in the solution) for aqueous lithium and calcium chlorides solutions up to very high concentrations (far higher than any we have so far measured). He finds a linear relation up to 30 per cent. lithium chloride and 20 per cent. calcium chloride respectively, after which the curves bend. The essential difference between his method of plotting and ours is that we take into our conductance expression the density of the solution. If his curves are modified in this way, the changes in direction at the high concentrations become far less marked, and their courses at more moderate concentrations, whilst becoming somewhat less linear, closely approximate in type to those found by us for solutions of lithium chloride and other salts.

A. J. ALLMAND.
L. NICKELS.

University of London,
King's College, Strand, W.C.2,
November 25.

The London Fogs of November 25-27, 1923.

THE accompanying graph (Fig. 1) shows the hourly variation in the quantity of suspended impurity, that is, sooty matter, in the air of London (Westminster), which was chiefly responsible for the recent smoke fogs. This curve shows clearly that the maximum density of the smoke fog occurred about mid-day, and there was a rapid increase in density which coincided

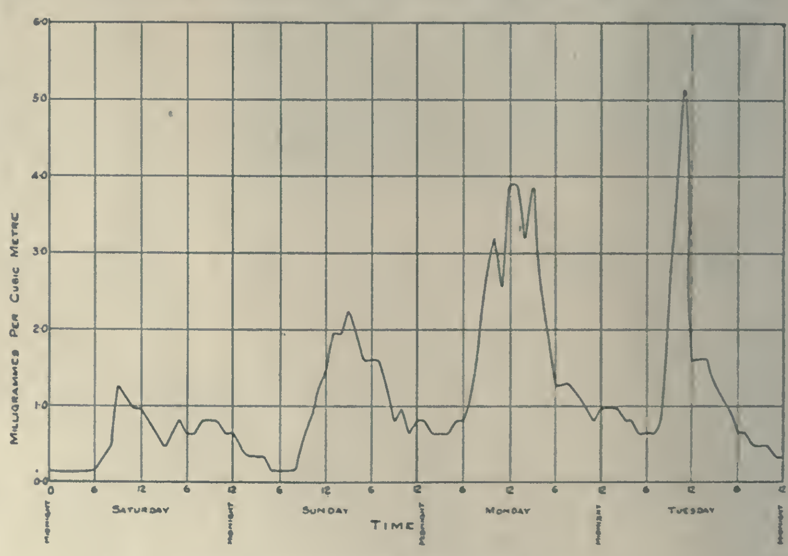

FIG. 1.—Suspended impurity in the air of Westminster, November 24-27, 1923.

with the period of lighting up of fires in the morning. The figures from which the curve is plotted were obtained from my automatic recorder, designed for the Advisory Committee on Atmospheric Pollution. When a large number of days are averaged, and

plotted, the distribution over the 24 hours is similar but more uniform, and it can even be seen that the maximum is reached later on Sundays than on week-days (Eighth Report Advis. Comm. on Atmos. Pollution, p. 30).

Records taken in Westminster by my impact apparatus at the height of the recent fogs showed about 50,000 solid particles per cubic centimetre, and very little indication of water drops. These particles averaged a little more than 0·5 micron in diameter, and there was a tendency to a rounded, kidney shape, with a fair number of small transparent spheres of about the same diameter.

With reference to the cause of the "London Particular," the view is generally held that a London fog consists of condensed water particles dirtied by smoke and oily hydrocarbons (Carpenter, "London Fog Inquiry," 1901–2), and this view follows naturally from the fact that during London smoke fogs there is very often a dense water fog in the surrounding country. There are, however, certain indications which point to a different conclusion and suggest that a London smoke fog, such as we have experienced recently, occurs at the same time as the surrounding water fog, not because it is a result of the latter, but because of the conditions which favour water fog. I have, therefore, been forced towards the view that the smoke fog of London does not consist of water particles dirtied by smoke, but almost entirely of smoke particles alone. In support of this are the following facts:

(*a*) During the recent fogs when the sun was visible at all it appeared as a red ball, thus pointing towards the presence of finely divided suspended matter, and not towards large water globules.

(*b*) Records taken by my impact method during London smoke fogs show little evidence of water drops, which, if present, would be obvious; but there are always immense numbers of small smoke particles.

(*c*) It is not unusual in coming up to London from the country during foggy weather to find a dense white fog in the country, with a limit of visibility of perhaps 50 yards, giving place to a yellow fog in London with a greater limit of visibility; thus, while a large amount of smoke can always be detected, there must be a great reduction in the quantity of water in the London fog, since in spite of the smoke addition visibility improves.

(*d*) The air over London is warmer than in the country surrounding, and although the combustion of large quantities of fuel supplies a certain amount of water to the air, it seems probable that condensation of water in London to form fog would normally be much less than in the surrounding country. There are about 17,000,000 tons of coal burnt per annum in London, and assuming a wind of 2 miles per hour and an inversion of the lapse rate of temperature at about 400 feet, a condition likely to be met with during foggy weather, this amount of coal would keep the air immediately over London about 13° F. warmer than in the surrounding country.

(*e*) The hourly incidence of suspended impurity, as shown in the curves, varied exactly with the darkness and apparent density of the fogs as judged by the eye.

Doubtless in the early morning the conditions which cause a water fog in the country also cause a similar fog in London, if not so dense; but as the day advances the smoky fires add their soot and heat to the air, the latter evaporating the water and the former replacing it by soot.

Fires are notoriously smoky shortly after lighting until they get well heated up, and we find, as a rule, that the smoky London fog commences in the morning about the time of fire lighting and dies away gradually as the fires become well established; while it is usually at a minimum between midnight and early morning. If the natural ventilation over the city fails to carry away the smoke produced, there is sufficient evolved in the morning in three or four hours to provide Londoners with the densest smoke fog they have ever experienced. Such a fog contains 5 or 6 milligrams of soot per cubic metre, and this can be easily supplied by the 40 or 50 tons of soot evolved per hour by the chimneys of London.

Assuming the correctness of the above, we may draw the following inferences:

(1) The air over London being warmer than its surroundings, water fogs will be fewer or less dense during the day than in the country.

(2) The "London Particular" can be entirely prevented by abolishing smoke.

J. S. OWENS.

47 Victoria Street, Westminster, S.W.1,
December 4.

Upper Air Conditions after a Line-Squall.

METEOROLOGISTS are indebted to Wing-Commander L. W. B. Rees for some very valuable observations during two aeroplane ascents at Cranwell (Lincs.) on October 19, showing the change which took place in upper-air conditions during the passage of a "line-squall" or, in the phraseology of Bjerknes, a "cold front." Observations of this kind are sufficiently rare, and the features exhibited by the present ones are so specially interesting that it seems very desirable to lay some emphasis on them.

The accompanying diagram (Fig. 1) shows the details of the records. The first ascent (dotted line) commenced at 9.15 A.M., and was made in front of the line-squall in the "equatorial air," the origin of which has now been traced back, on the charts in the Meteorological Office, to a low latitude. The figures against the curve show the relative humidity at various levels, the corresponding number of grams of water vapour per kilogram of air being given in brackets. It is necessary to remark that the report of cloud and rain encountered is not inconsistent with the apparently unsaturated condition of the air, for the cloud was not necessarily continuous throughout the thickness indicated, and, further, the instruments were read on the way up when the clouds were only just commencing to thicken and form rain. No rain reached the surface until 10 A.M. The line-squall occurred at 10.5 A.M., marking the arrival at the surface at Cranwell of the "polar air" which has been traced back to the neighbourhood of Greenland. The usual line-squall features were recorded—heavy rain, sudden veer of wind from S.S.W. to W., and sudden fall of temperature of 9° F. All the rain, 2·1 mm., occurred between 10 A.M. and noon, and presumably fell through the undercutting wedge of colder air from the "equatorial air" above. The second ascent (full line) commenced at 2.15 P.M. in response to a request by wireless telegraphy from the Forecast Division of the Meteorological Office, Air Ministry, where the first record had been received and the weather charts showed how valuable another would be.

The second record shows that the aeroplane left the ground in the "polar air" and penetrated the "equatorial air" above, but what is particularly striking is the extreme dryness of the intermediate layer extending from about 5000 ft. to 9000 ft. When a sharp discontinuity is absent between two different air currents the effect is usually attributed to mixing at the interface, but the present intermediate layer some 4000 ft. thick cannot possibly have been a

"mixing layer," for it contained a much smaller proportion of water vapour per mass of air than the layers above and below. The following considerations suggest that it belonged purely to the lower current and was, indeed, the only genuine "polar air" surviving over Cranwell.

Let the shaded figure (*a*), in the inset diagram, represent, schematically only, a vertical section (vertical scale much magnified) of a "tongue" or "globule" of cold air which has not long since penetrated from a cold source into a warmer environment. Subsequent translation and lateral spreading under gravity may lead to a condition, now at a distance from the cold source, represented by fig. (*b*), the line-squall taking place, say, at the right-hand edge. A contribution to the study of such motion has been made by Exner [Sitzungsber. Akad. Wiss. Wien, IIa, 127, 1918, pp. 795-847]. In the transition the air at A descends to C, while the surface air remains at the surface, so that the higher a layer was originally the more it is warmed adiabatically. Hence

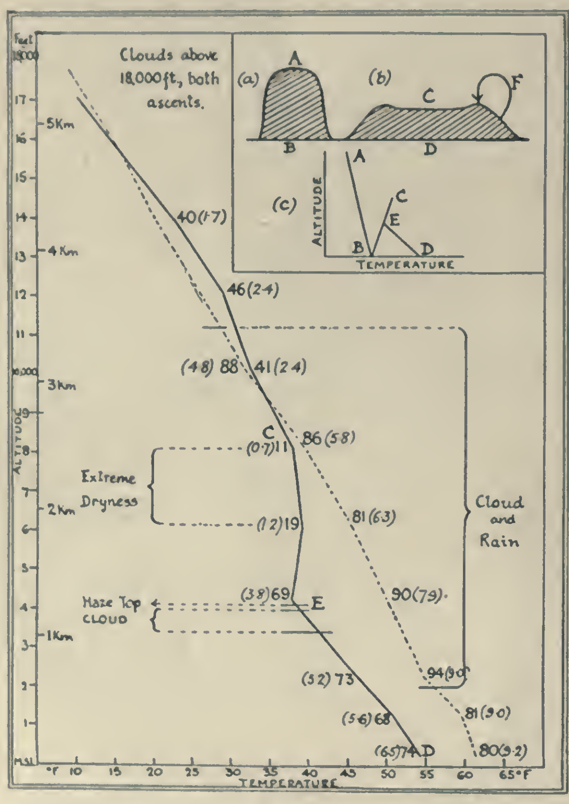

FIG. 1.

if the original lapse-rate, represented by AB in fig. (*c*), is less than the adiabatic, as is reasonable for air cooled mainly from the surface in high latitudes, it will become, from this cause alone, more remote still from the adiabatic, like CB, where AC is the slope of the "dry adiabatic." A more precise mathematical treatment of such a change of lapse-rate has been given by Margules (Exner, "Dynamische Meteorologie," 1917, p. 80). Any change of pressure, at a given level, during the transition would produce effects which would not appreciably modify that demonstrated. The sinking of the globule thus tends towards greater stability and therefore to oppose turbulence. But in passing over a relatively warm surface such as the Atlantic the cold air mass would receive heat from below, and this would be diffused upwards as far as the turbulence originating at the surface is able to penetrate in the face of the stabilising action of the sinking. A lapse line like CED would result, where E is the upper limit of mixing.

In the present case there is clear evidence of the upper limit of turbulence in the "haze-top" reported at about 4000 ft., and the layer ED in the main diagram was accordingly the one which had been warmed from below; it possessed the "dry adiabatic" lapse-rate of temperature indicative of thorough mixing, and was fairly humid, with cloud at the top, owing to water vapour, evaporated over the Atlantic, having been stirred up at the same time as the layer was warmed. The layer CE, on the other hand, was, on this view, one which had succeeded in remaining non-turbulent, and was really the only genuine "polar air" which reached Cranwell, still possessing the original low polar water vapour content and, neglecting radiation, its original potential temperature. This view is strengthened by remarking that, although the moderate decrease of humidity and small rise of temperature indicated by the upper parts of the two records may be explained, using a Hertz diagram, by supposing the "equatorial air" to have ascended, lost some moisture as "cold front" rain, and descended again, as suggested at F in fig. (*b*), no such explanation can be applied to the extremely dry layer discussed above, for the air would have to be taken to an unreasonably great height, and would also arrive back with far too high a temperature. It does not seem, therefore, that the intermediate layer can have been evolved out of the "equatorial air," and these interesting records are accordingly to be interpreted as showing that the air of polar origin over Cranwell was in all probability a "tongue" or "globule" about 9000 feet thick with the lower half partially "depolarised." Subsequent weather charts suggest that it was soon replaced again by a warmer air current right down to the surface.

Such pairs of records as this, near "cold fronts," are uncommon, the nearest approach amongst those published in the Daily Weather Reports being in the issues of October 14 and 15, 1921, two ascents at Baldonnell (Dublin) having exhibited similar features to the present. They are also important as bringing into prominence the existence well within areas of cyclonic activity of "dry inversions," the occurrence of which is more commonly associated with the margins of anticyclones.

M. A. GIBLETT.

Meteorological Office,
Air Ministry, Kingsway, W.C.2,
November 14.

Experiments on *Ciona intestinalis*.

IT is remarkable that in all the statements that I have seen by Dr. Kammerer or Prof. MacBride concerning the increase in length of the siphons in Ciona following amputation, no measurements are given. As I have recently made measurements on a number of specimens in order to obtain some data indicating the natural variation in the proportional length of the oral siphon, I should be glad if Prof. MacBride would inform us whether Dr. Kammerer has published, or whether he possesses unpublished, any measurements of the siphons in his specimens before and after amputation, and in the offspring which inherited the increased length.

I find it difficult to understand what Prof. MacBride means by the words "the reaction is of the animal as a whole." It may be a fact that amputation of both siphons results in the growth of longer siphons, and of the oral siphon alone in the growth of a siphon of the same length as before, but I do not see how

the "reaction of the animal as a whole" explains the fact.

Prof. MacBride has a photograph of an operated Ciona and a normal one side by side. What is the proportional length of the oral siphon in a "normal" Ciona, and what was that length in the operated siphon before operation and after regeneration?

J. T. CUNNINGHAM.

East London College,
Mile End Road, London, E.,
November 24.

Mrs. Hertha Ayrton.

IT must be a matter of pain and surprise to many readers of NATURE that Professor Armstrong should have written such an article as that which appears on p. 800 of the issue of December 1.

I was privileged to know, with the intimacy which is only possible to a doctor, both Prof. and Mrs. Ayrton during many years. He was my patient until he died—prematurely in one sense, but in another he lived long, and accomplished more than many men who live to extreme old age. It seems almost sacrilege to speak of their married life, or of the perfect sympathy and companionship which distinguished it; it is difficult to understand how any one professing to have been their friend could suggest that they were "an ill-assorted couple."

No woman could have nursed her husband with more untiring, unselfish, and tender devotion. Of their scientific work I leave others to speak; there will surely be many who will vindicate their memory in this respect. But as an old and intimate friend I am well qualified to protest against the heartless comments upon the private life of a very noble woman of whose living presence we are so recently bereaved. The Latin races respect their dead friends with an emotion we can at least respect. The Day of the Dead, held in reverence probably surpassing anything in the Christian ritual, has scarcely passed this year, and yet Prof. Armstrong can write such an article upon his dead friends. Surely for the rest of his life he will regret not having declined that "appeal" for an obituary notice.

H. H. MILLS.

21 St. Mary Abbot's Terrace,
Kensington, W.14,
December 3.

The only comment I can possibly make on the above is, that the writer must be strangely lacking in sense of humour.

When I used to tell my friends that they were "ill-assorted," knowing this full well and knowing me, they did but smile. As did Mrs. Ayrton—when, to terminate one of our fruitless discussions on the woman as man, I sometimes said: "We will admit you are 'up to us' (apart from being yourselves), when you are regularly engaged as chefs and produce one to go down to posterity with Soyer."

May I here note the need of a correction in my article—the insertion of the accent over the first *e* in Mélisande? So beautiful a name should not be reft of the least shade of its charm.

HENRY E. ARMSTRONG.

Zoological Bibliography.

LEST it should be assumed from my friend Dr. Bather's communication to NATURE of December 1, page 794, that my letter was premature, let me state that my communication was forwarded to NATURE at the express wish of the Conference of Delegates and with the concurrence of the various officers of the British Association, who were present at the time.

There is no misunderstanding whatever as to the wishes of the representatives of the numerous scientific societies present in regard to the size of publications, and if Dr. Bather will consult such a publication as Collins's "Authors' and Printers' Dictionary," issued by the Oxford University Press, he will find that demy-octavo is slightly less than the measurements he gives, namely, $8\frac{3}{4} \times 5\frac{1}{2}$ in., and this is the size which that particular committee recommends to all societies publishing annual reports, etc.

T. SHEPPARD.

The Municipal Museums, Hull.

Micelles and Colloidal Ions.

MR. W. B. HARDY in his letter to NATURE of October 13, p. 537, entitled "The Micelle—A Question of Notation," advocates the conception of the colloidal ion and postulates that the ideas of other workers coincide with his own, so that merely a question of nomenclature is involved; nevertheless, in his opinion, it is positively wrong to refer to a colloidal ion as a micelle.

It will be shown in a paper by Miss M. E. Laing which we hope to publish in an early number of the *Journal of Physical Chemistry*, that all movement in an electric field can be summed up in a single formula which applies equally to ions, diaphragms, gels, suspensions, micelles, etc., and governs the movement of any such charged constituent relative to the solvent. The experimental evidence shows that there is a gradual transition from uncharged or isoelectric colloidal particles, through those which are very slightly charged, such as the neutral micelle in soap solution or the particles in a gold sol, to those which are much more highly charged, like the ionic micelle of soaps, and then to the true ions which are fully charged.

Now comes the question of nomenclature. There is no question as to the fully charged ion where this coincides with the chemical unit. In soap solutions, however, there is a sharp distinction between the behaviour of the single crystalloidal molecules or ions and their respective aggregations, the neutral and ionic micelles, which, for example, can be held back by an ultrafilter.

It would seem as repugnant to designate an aggregate of soap ions containing substantial proportions of undissociated soap and of solvent a "colloidal ion" as it would be to call aggregates of hydrated neutral soap, which are probably the structural basis of soap jellies, "colloidal molecules," although one is as logical as the other. I have called each of these aggregates a micelle, and have described their electrical condition by adding the prefixes neutral and ionic respectively. The term micelle is customarily employed in a similar sense in contemporary French and German science.

JAMES W. MCBAIN.

Dept. of Physical Chemistry,
University of Bristol.

Biography of Richard A. Proctor.

WE are at present engaged in the preparation of a "Memoir" of the late Richard A. Proctor, and to assist us in our work we should be deeply grateful for the loan of any letters which readers of NATURE may have received from him. We will carefully preserve the letters and return them as soon as possible.

S. D. PROCTOR-SMYTH.
MARY PROCTOR.

9 Orchard Road, Altrincham, Cheshire,
December 3.

The Treatment of Disease by Artificial Light.

PHOTOTHERAPY, or the treatment of disease by light, was first prominently brought to the notice of the medical profession by the work of Finsen in 1895. He demonstrated that the rays of the visible spectrum, and also those invisible radiations which we call ultra-violet rays, have varying therapeutic qualities. He showed that the exclusion of the ultra-violet rays from the skin of patients suffering from smallpox cut short the secondary fever characteristic of this disease, and diminished the suppurative stage, and, thereby, shortened the duration of the illness and lessened the risk of ugly scarring. On the other hand, he proved that the local application of concentrated actinic light had a powerful influence on certain affections of the skin, particularly on the common type of cutaneous tuberculosis known as lupus vulgaris. Before his death he had already appreciated the value of a more general application of light, namely, the exposure of the whole body to radiation.

In his earlier experiments with concentrated light, Finsen used the sun; and a simple apparatus consisting of a large hollow lens containing a blue solution was the means by which the actinic rays of light were brought to a focus upon the skin. Even with a blue medium used as a filter it was found necessary to interpose a cooling apparatus at the focus of the lens. This apparatus consisted of a small circular chamber with quartz faces through which a current of cold water constantly circulated. In addition to its value as a method of preventing excessive heating of the part, this apparatus was also used as a compressor to render the area under treatment bloodless, as it had been found by experiment that the actinic rays penetrated a blanched skin, whereas in that through which the blood was circulating the red colouring matter of the blood prevented the passage of the blue and ultra-violet rays. In Denmark, as in other countries in northern latitudes, the number of days on which the sun could be utilised was so limited that Finsen soon abandoned the sun as an illuminant and substituted powerful electric arc lights.

Following on Finsen's discovery, a number of workers in this field devised other forms of illuminant, and several lamps of high actinic power became available.

It is interesting at this point to consider the work of Rollier at Leysin. For more than twenty years he has been treating cases of tuberculosis, particularly in children, by exposing the surface of the body to the alpine sun, and his efforts have achieved a striking success. At first it was believed that the air of the high altitude was the determining factor in the admirable results obtained, but it has since been shown that it is the light which is the important agent. Rollier's success stimulated others in this branch of phototherapy, and at the Treloar Homes at Alton and Hayling, Hants, Sir Henry Gauvain has shown the practical value of this measure, even in this climate, in the treatment of tuberculous disease of the bones, joints, and skin. More recently, Reyn, in Copenhagen, has shown that the carbon arc light can be used as a substitute for the sun, and that the results of an electric light bath are as efficient as the sun bath.

The treatment of disease by artificial light, therefore, must be considered from two points of view. First, the local application of the radiations to the diseased focus, and second, the application of light to the whole of the surface, which for convenience we may call the "light bath." First, the local application of light to a diseased area; here we find two methods in use, one in which the light is concentrated by means of lenses, and the other in which reliance is placed on the intensity of the actinic radiations, without concentration.

LOCAL TREATMENT BY CONCENTRATED LIGHT.—The typical apparatus for treatment by concentrated actinic light is the Finsen lamp, or its modification the Finsen-Reyn lamp. The essentials in these are a powerful carbon arc with an automatic adjustment to approximate the carbons as they burn away. The light from the arc is focussed through a series of rock-crystal lenses in a tube containing distilled water. The rays are focussed on an area the size of a shilling, and at the focus is placed the combined compressor and cooling apparatus with a cold-water circulation described above. This type of apparatus is used mainly in the treatment of the form of tuberculosis of the skin known as lupus vulgaris. After an hour's application of the concentrated rays an inflammatory reaction occurs in the skin. The inflammation is so acute that a blister forms which may take several days to a couple of weeks to heal. It is interesting that this reaction does not begin till about six hours after the treatment. Repeated applications are usually necessary to destroy the effects of the invasion of the skin by the tubercle bacillus, but in 60 to 70 per cent. a permanent cure is obtained, many of the patients treated having been watched for twenty years.

In the original Finsen apparatus the current used is 70 volts and 50 amperes. It is therefore advisable to use a transformer when the available current has a high voltage, say 240 to 220. The carbons used are: positive, cored, 25 mm. in diameter and 12 inches long; negative, solid, 18 mm. in diameter and of the same length. By this apparatus four patients can be treated simultaneously.

In the Finsen-Reyn lamp the illuminant is of the scissors type, the current employed being 70 volts, 20 amperes. The positive carbons are cored 12 mm., the negative solid 10 mm. in diameter and 8 inches long. These lamps can be worked from the lighting mains, say of 240 volts in series, with appropriate shunts. One patient only at a time is treated with each Finsen-Reyn lamp.

LOCAL TREATMENT BY UNCONCENTRATED LIGHT.—The most convenient type of apparatus for the local treatment of diseased areas of the skin by unconcentrated light is that devised by Kromayer. It consists of a U-shaped envelope of rock crystal containing mercury vapour. This is surrounded by a second envelope with a rock-crystal window. Between the two envelopes, which are fitted in a metal box, cold water circulates, to absorb the heat rays. The window of the apparatus is pressed firmly against the area of skin to be treated, the pressure being of value in rendering the skin bloodless, and thus increasing the penetration of the ultra-violet rays. The apparatus is fixed on a mobile stand, and can be used off any ordinary

direct electric lighting circuit. On a 240 volts circuit the current used is 3·5 amperes with 120 volts across the arc. It will be noted that a water supply is necessary, a circulation of four pints per minute being required.

LIGHT BATH TREATMENT BY THE CARBON ARC LIGHT.—The experience of Reyn of Copenhagen, confirmed by other observers, is that the best illuminant is carbon arc light. The spectrum of the carbon arc more nearly approaches that of the sun than does that of mercury vapour, and in the experience of the London Hospital, this is further increased by the use of carbons with a tungsten paste core, tungsten giving a spectrum of great richness in ultra-violet rays.

The installation is very simple. A large carbon arc lamp, working at 50 amperes and 70 volts, is suspended from the ceiling at three to three and a half feet above the floor. Around this, at a distance of from three to four feet, the patients, nude, are seated on stools. The whole of the body is exposed, first the front and then the back, the sittings being of half an hour's duration at first, and these are gradually increased up to four hours a day. When the front of the body is under treatment the eyes are carefully protected by a thick mask. The tungsten paste cored carbons used are (+) cored, 25 mm., (−) solid, 18 mm., both 12 inches long.

GENERAL TREATMENT BY MERCURY-VAPOUR LAMP.—The apparatus consists of a quartz lamp or "burner" containing mercury vapour, behind which are placed reflectors of various shapes. The lamp is mounted on a stand which permits its being placed at an appropriate height. It is worked off any direct electric current, and is inexpensive to run. The practical life of a "burner" is, in the larger types, about 1000 hours. A very high actinic illumination is obtained. The patient lies or stands while under treatment, usually at a distance of about three feet, but with the larger model supplied by the Hewittic Electric Company, the maximum distance at which a patient is sensible of the radiation is eighteen feet. At the beginning of the treatment the exposures are given to small areas, and both the area and the duration may be gradually increased until the whole of the back or front of the body is exposed for half an hour. An inflammatory reaction, redness, slight vesication with subsequent desquamation, are common, and after a series of exposures, the skin in the majority of patients becomes strongly pigmented. Several of these lamps may be placed in a suitable apartment, the patients being allowed to move about. The mercury-vapour lamp has been used with success in the treatment of tuberculosis of the skin, glands, bones, and joints. Care is required in the dosage, and it is advisable to estimate the intensity of the actinic rays by a chromo-actinometer. This is specially necessary when a new "burner" is installed.

It has been shown that rickets can be prevented in animals fed on a ricket-producing diet if the surface of the body is exposed to the radiations from a mercury-vapour lamp, and there is an important field of usefulness for this form of radiotherapy carried out with due precautions in the treatment of early rickets in children.

CONCLUSION.—The sphere of usefulness of the light bath is being explored in several directions. A committee appointed by the Medical Research Council is studying the biological action of light, and several valuable investigations have been made. Among others it has been demonstrated that the bactericidal power of the blood of animals can be greatly increased by the exposure of the animal to actinic light. Clinical observation shows that there is a remarkable effect upon the metabolism of the human subject; dull, lethargic patients rapidly become bright, cheerful, and active. The body weight increases in many instances. Chronic tuberculous affections of the skin, mucous membranes, bones, and joints heal rapidly. Other chronic processes, such as rheumatoid arthritis, have also been benefited. The value of light in the prevention and treatment of rickets has been noted above. A course of treatment usually lasts three to five months. Patients whose skin pigments well usually do best, but there is no evidence to show that it is the pigmentation which is the curative factor. At present it can only be considered an index. Evidence so far points to the actinic rays producing some possibly chemical change in the blood which gives it greater power to destroy bacteria and their products.

Some Aspects of the Physical Chemistry of Interfaces.[1]

By Prof. F. G. DONNAN, C.B.E., F.R.S.

IN recent years a great deal of attention has been paid by chemists, physicists, and physiologists to the phenomena which occur at the surfaces or interfaces which separate different sorts of matter in bulk. Things could happen in these regions which did not occur in the more homogeneous and uniform regions well inside the volume of matter in bulk. A surface or surface layer represents a sort of thin cross section which can be probed and examined much more readily than any part of the inside bulk. The living organisms of plants and animals are full of surfaces and membranes. What can happen at surfaces is therefore a matter of great importance for the science of living things.

An essential characteristic of the ordering or arraying of molecules and atoms which seems to occur at surfaces may consist in *special orientation*. In the chemical and physical actions occurring in a volume of liquid the bulk of which is large compared with its surface, the molecules or atoms probably move towards each other with every sort of orientation. Should, however, some special orientation be characteristic of interfaces, then it is clear that such interfaces will exhibit new phenomena due to this special sort of arraying. Moreover, if we are dealing with molecules which are ionised into electrically polar constituents, or which, if not actually dissociated, can be treated as electrically bi-polar, it follows that, if orientation occurs at interfaces and surfaces, then electrical double layers and electrical potential differences may be set up at such boundaries.

[1] From the presidential address delivered to Section B (Chemistry) of the British Association at Liverpool on September 14.

The field of force surrounding an attracting molecule may in reality be very "irregular," and may be specially localised around certain active or "polar" groups. Its region of sensible magnitude may be very variable and relatively small compared with molecular dimensions. The chemical constitution of the molecule is now regarded as determining the varying nature of the field of force surrounding it, so that parts of the molecule possessing high "residual chemical affinity" give rise to specially powerful regions of force. In this way the older "physical" theories of cohesion according to central forces with uniform orientation have been to some extent replaced, or at all events supplemented, by "chemical" theories according to which the attractive force-fields are highly localised round active chemical groups and atoms, are relatively minute in range, and can be saturated or "neutralised" by the atoms or groups of neighbouring or juxtaposed molecules.

W. B. Hardy has been the chief pioneer in the development of these newer theories, having been led thereto by his researches on surface tension, surface films, composite liquid surfaces, and static friction and lubrication. If γ_A be the surface tension of a liquid A, γ_B that of another practically immiscible liquid B, and γ_{AB} the interfacial tension at the interface A/B, then the quantity $W = \gamma_A + \gamma_B - \gamma_{AB}$ represents the decrease of free surface energy, and therefore the maximum work gained, when a surface of A is allowed to approach normally and touch a surface of B at constant temperature. Comparing different liquids A with water as a constant liquid B, Hardy has shown that the quantity W is extremely dependent on the chemical constitution of A, and is especially high when A contains the atomic groups characteristic of alcohols, acids, and esters. Thus, for such saturated substances as octane, cyclohexane, CS_2 and CCl_4, the values of W at ordinary room temperature lie between 21 and 24. Compare with these values the following:

(*a*) Introduction of a hydroxyl group:

Octyl alcohol . . .	46
Cyclohexanol . . .	51·4

(*b*) Introduction of a carboxyl group:

n—Caprylic acid . . .	46·4
Oleic acid . . .	44·7

The natural inference from results such as these is that the cohesional forces are essentially chemical in origin and that they depend in large measure on the presence of "active" atoms or groups of atoms, namely, those possessing strong fields of "residual chemical affinity"; in other words, powerful and highly localised stray fields of electrical or electromagnetic force (or of both types). The existence of such atoms or atomic groups is strong presumptive evidence of the unsymmetrical fields of force postulated by Hardy and therefore of the molecular orientation at surfaces.

This question of the orientation of molecules at the surfaces of liquids has been greatly extended in recent years by a detailed study of the extremely thin and invisible films formed by the primary spreading of oily substances on the surface of water. In a continuation and development of the work of Miss Pockels, the late Lord Rayleigh showed many years ago that when olive oil forms one of these invisible films on water there is no fall in surface tension until the surface concentration reaches a certain very small value. He made the highly interesting and important suggestion that this concentration marks the point where there is formed a continuous layer just one molecule thick. In the case of olive oil, he found this critical thickness to be 10^{-7} cm., and concluded that this number represented the order of magnitude of the diameter of a molecule of the oil. This method was greatly developed by Devaux.

Although these researches had firmly established the theory of the formation of a unimolecular surface layer and therefore of the existence of a *new "two-dimensional" phase of matter,* we owe it to I. Langmuir to have made a very important advance by connecting this conception with the ideas of chemically active groups and molecular orientation. Influenced, no doubt, by the ideas of Hardy, Langmuir reasoned that the formation of these primary unimolecular films must be due to the presence of active groups in the molecules, which are attracted inwards towards the water and thus cause the long open chain molecules of the fatty acids to be oriented on the water surface with their long hydrocarbon axes vertical and side by side.

Working by means of the method of Devaux, Langmuir put these ideas to the test of experiment, and determined the internal molecular dimensions of a unimolecular layer. Calculation of the average distance between two adjacent carbon atoms in the three acids gave the value $1{\cdot}4 \times 10^{-8}$ cm. This distance must be of the order of magnitude of the distance between the centres of the carbon atoms in the crystal structure of a diamond, which is now known to be $1{\cdot}52 \times 10^{-8}$ cm.

These regularly oriented and unimolecular surface films on water have been recently investigated in a very detailed and careful manner by N. K. Adam, who has improved the method employed by Devaux and Langmuir. From a closer analysis of the relationship between the force of surface compression and the surface concentration (expressed as area occupied per molecule), he has shown that a distinction must be made between the close packing of the polar or active end groups (head groups) of the molecules and the subsequent close packing of the hydrocarbon chains.

Some interesting results have also been obtained in Sir William Bragg's laboratory by Dr. A. Müller. In these experiments layers of crystallised fatty acids on glass plates have been examined by an X-ray photographic method. From these results it appears that the unit cell is a long prism, the cross section of which remains constant for the substances investigated, whilst the length of the prism increases linearly with the number of carbon atoms in the molecule. The increase in length of the unit prism per carbon atom in the molecule is found to be $2{\cdot}0 \times 10^{-8}$ cm. Since it appears likely that there are *two* molecules arranged along the long axis of each unit cell (prism), it would follow that the increase in the length of the molecule per carbon atom added is $1{\cdot}0 \times 10^{-8}$ cm. Comparing this result with the value for the distance between the carbon centres in the diamond lattice, it would appear that the carbon atoms in the long hydrocarbon chains of the higher saturated fatty acids are arranged in a zig-zag, or more probably in a spiral or helix.

If this be the case, the closer packing or compression of the juxtaposed molecules in the unimolecular films, as revealed in the investigations of Devaux, Langmuir, and Adam, may be to some extent explained by the straightening out of these zig-zags, or perhaps by the "elastic compression" of the helices.

As pointed out by Langmuir, the question of the formation of unimolecular surface films can be attacked in a different manner. It is known that gases or vapours can be condensed or adsorbed by solid and liquid surfaces. The question then arises, does the formation of primary unimolecular films ever occur in such cases? It will be recollected that Hardy made the suggestion that the formation of the primary unimolecular film in the spreading of oily substances on water might be due to adsorption from the vapour. In order to examine this question, Mr. T. Iredale has recently measured in my laboratory the fall in the surface tension of mercury caused by exposing a fresh mercury surface to vapours of increasing partial pressure. The excess surface concentration q of the adsorbed vapour can then be calculated by means of Gibbs's formula

$$q=-\frac{\rho d\gamma}{dp},$$

where γ=surface tension, and ρ and p denote the density and partial pressure of the vapour respectively. Working with the vapour of methyl acetate, Iredale found in this way that at a temperature of 26° C. and a partial pressure of 62 mm. of mercury, $q=4\cdot5\times10^{-8}$ gm. per square centimetre of surface. From this result we can readily calculate that there are $0\cdot37\times10^{15}$ molecules of methyl acetate adsorbed per sq. cm., and that the area per molecule is 27×10^{-16} sq. cm. As under the conditions corresponding to this calculation the molecular surface layer was probably not quite saturated (in the unimolecular sense), we may expect the value found to be of the same order of magnitude but somewhat greater than the values found by Adam for the cross section of the head group of the higher saturated fatty acids (25×10^{-16}) and of the esters (22×10^{-16} for ethyl palmitate and ethyl behenate). We may, therefore, say that Iredale's results appear to indicate the formation of a primary unimolecular layer built up by adsorption from the vapour phase.

Langmuir has measured the adsorption of a number of gases at low temperatures and pressures on measured surfaces of mica and glass, and has arrived at the conclusion that the maximum quantities adsorbed are always somewhat less than the amounts to be expected in a unimolecular surface layer. E. K. Carver, who has measured the adsorption of toluene vapour on known glass surfaces, has arrived at a similar conclusion. The view that the *maximum* adsorption from the gas phase cannot exceed a unimolecular layer has, however, been much criticised.

Let us now consider another type of formation of surface layers at the surfaces of liquids—namely, the case where a substance dissolved in a liquid concentrates preferentially at the liquid-air or liquid-vapour interface. Gibbs, and later J. J. Thomson, have shown that if a dissolved substance (in relatively dilute solution) lowers the surface tension, it will concentrate at the surface. That such a phenomenon actually occurs has been qualitatively demonstrated in the experiments of D. H. Hall, J. von Zawidski, and F. B. Kenrick and C. Benson, by the analysis of foams and froths. In 1908 S. R. Milner used the same method in the case of aqueous solutions of sodium oleate, and arrived at a mean value of $1\cdot2\times10^{-10}$ gram mols. excess concentration per sq. cm. of surface. In the case of dilute solution, we can calculate q, the amount concentrated or "adsorbed" in the surface per sq. cm. (excess surface concentration), and Milner calculated from Whatmough's data for aqueous solutions of acetic acid that the "saturation" value of q is $3\cdot3\times10^{-10}$ mols. per sq. cm., from which it follows that the area per molecule in the surface is 50×10^{-16} sq. cm. In a similar manner, Langmuir has calculated from B. de Szyszkowski's data for aqueous solutions of propionic, butyric, valeric, and caproic acids that the surface area per molecule adsorbed in the saturated layer is equal to 31×10^{-16} sq. cm., while Harkins has arrived from his own measurements for butyric acid at the value 36×10^{-16} sq. cm.

In 1911 Dr. J. T. Barker and I made a direct determination of q for a solution of nonylic acid in water. For a practically saturated surface layer it was found that q was about $1\cdot0\times10^{-7}$ grm. per sq. cm., or $3\cdot1\times10^{14}$ molecules per sq. cm. From this result it follows that the surface area per molecule is 26×10^{-16} sq. cm.

These values are not very different from the values found by Langmuir and by Adam for the oriented unimolecular layers of practically insoluble fatty acids resting on the surface of water. That in the present case some of the values are larger might easily be explained on the ground that these adsorption layers are partially, or completely, in the state of "surface vapours." For Adam and Marcelin have recently made the important discovery that the unimolecular surface films investigated by them may pass rapidly on increase of temperature from the state of "solid" or "liquid" surface films to the state of "vaporised" surface films, in which the juxtaposed molecules become detached from each other and move about with a Brownian or quasi-molecular motion.

It is, indeed, highly probable that the molecules which are concentrated in the surface from the state of solution in the liquid phase are not in quite the same situation as the molecules of practically insoluble substances which are placed *on* the surface. In the former case the molecules are still "dissolved," so that they will be more subject to thermal agitation and less able to form a juxtaposed unimolecular layer. They may also be "hydrated." Nevertheless, the agreement as regards order of magnitude in the values of the surface area per molecule in the two types of case is certainly very suggestive and significant.

Let me now direct attention to another very interesting phenomenon relating to the surfaces of liquids and solutions—namely, the existence of an electrical potential gradient or potential difference (P.D.) in the surface layer. The liquid-gas interface offers the simplest case of such interfaces, so the investigation of the potential differences which may exist at this interface is a matter of fundamental interest. In 1896 F. B. Kenrick developed,

on the basis of earlier experiments of Bichat and Blondlot, an electrometric condenser method for the comparative determination of the gas-liquid P.D.'s. The results which he obtained show that substances (such as the aliphatic alcohols and acids) which concentrate at the surface produce a very great change in the surface P.D., whilst highly dissociated univalent inorganic salts, such as potassium chloride, do not. The results obtained by Kenrick have been much extended by an investigation carried out with the same type of apparatus by Prof. T. Thorwaldson in my laboratory. The general result of these experiments can be described in the following terms:

Consider the system:

Aqueous solution of KCl (conc. $=c$) A	Air	Aqueous solution of KCl (conc. $=c$) B

The positive potential of A will be equal to that of B. If we now add to the solution B a small quantity of a substance S (generally a non-electrolyte or weak electrolyte) which has a strong tendency to concentrate at the air-B interface, it is found that the positive potential of A rises markedly above that of B, the value of the quantity, positive potential of A minus that of B, varying with the concentration of S in the way that is characteristic of adsorption phenomena. What is the interpretation of this phenomenon?

Quincke has shown that a bubble of air in water placed in an electrical potential gradient travels towards the anode—*i.e.* the bubble behaves as if it were negatively charged. From this it would follow that the P.D. at the air-water interface is such that the *negative* half lies towards the air side. As an electrolyte such as potassium chloride is negatively adsorbed at an air-liquid surface, it is probable that a P.D. of the character indicated by Quincke's experiment exists at the A-air interface. If we accept this conclusion, it follows that the effect of S is markedly to *reduce* this P.D. (or to reverse it). Now the P.D. at the air-water interface is probably due to the existence of a double layer containing hydroxyl ions on the outside and hydrogen ions on the inside, or to oriented water molecules regarded as electrical bi-poles. If S is a non-electrolyte (or a substance which possesses little self-ionisation), we can understand why its concentration at the surface could result in the reduction of this P.D.

Within the last few years H. A. McTaggart has made a number of experiments on the electric cataphoresis of gas bubbles in aqueous solutions and other liquids. He finds that aliphatic acids and alcohols in aqueous solution reduce the surface P.D., and that this effect runs parallel with their influence on the surface tension of water. He also finds that acids reduce the P.D. These results may be regarded as a corroboration of those obtained by Kenrick. McTaggart has found that the nitrates of tri- and tetravalent cations have a powerful effect in not only reducing but even reversing the P.D. (*i.e.* the bubble becomes positively charged). His experiments also show that polyvalent negative ions, such as the ferrocyanide ion, act in the opposite direction to the polyvalent cations—*i.e.* they increase the negative charge on the bubble or diminish a previously existing positive one.

The subjects which I have been discussing have an interesting bearing on the formation and stability of foams and froths. If air be violently churned up with water, only comparatively large bubbles are produced, and these quickly rise to the surface and burst. If now a very small quantity of a substance which concentrates at the air-water interface be added, an almost milk-white "air emulsion" of small bubbles is produced, which rise to the surface and produce a relatively durable froth. It is clear that the diminution in interfacial tension facilitates the subdivision or dispersal of the air. The existence of the surface layer will also confer a certain amount of stability on the resultant froth, since it will give rise to forces which resist the thinning of a bubble wall. Any sudden increase in the surface will produce a momentary diminution in the concentration or "thickness" of the surface layer, and hence a rise in surface tension, which will persist until the normal thickness or concentration is readjusted by diffusion of molecules from the inside volume—a process which in very dilute solution will occupy a perceptible time.

(*To be continued.*)

Obituary.

Dr. Alexander Gleichen.

The sudden and unexpected death of Dr. Alexander Gleichen on October 21 is reported from Berlin. Born at Niederschönweide on September 23, 1862, Dr. Gleichen commenced his higher education at the Neu-Ruppiner Academy, and later studied mathematics and natural philosophy at the University of Berlin. After passing his final examination at the University of Kiel, he became an assistant and then a head teacher at the Kaiser-Wilhelm Academy. At the same time he acted as "Privatdozent" at the Technical High School of Charlottenburg, where he lectured upon geometrical optics, a subject with which his name will always be associated. He also lectured upon mathematics at the Helene Lange College for Women.

Dr. Gleichen's academic career terminated in 1904, when he was called to the German Patent Office, with which he was connected until the end of 1918. While thus occupied, he was able to produce the *Archiv für Optik*, and later to act as editor of the scientific and technical sections of the optical and mechanical central journal. From 1919 until his death Dr. Gleichen was engaged in the scientific work of the C. P. Goerz optical establishment, where the opportunity was afforded him of applying his special knowledge of ophthalmic theory to the satisfaction of the ever-increasing demands of the spectacle industry.

Beyond Germany, Dr. Gleichen is best known as a writer of optical text-books of particular value to the student whose object it may be later to apply his knowledge to the practice of the art. This combination of theory and practice is most marked in his "Schule der Optik," published in 1914, and in his "Theorie der modernen optischen Instrumente" of 1911. The latter

book was, in 1918, translated into English under the auspices of the Committee of the Privy Council for Scientific and Industrial Research. The "Schule der Optik" has been translated into Spanish. As a theoretical treatise, his first work, published in 1902 and later translated into French, the "Lehrbuch der geometrischen Optik," is generally regarded as his most valuable legacy to the literature of optics.

The long list of Dr. Gleichen's books and contributions to scientific journals and societies is indicative of a life the leisure hours of which were exclusively applied to the study and expression of the science to which he was devoted; and yet it was characteristic of Dr. Gleichen that he was never too absorbed in his own affairs to appreciate the needs of others and was ever ready to leave his desk to assist a fellow-worker.

JAMES WEIR FRENCH.

MR. G. D. MAYNARD.

THE untimely death of George Darell Maynard at the age of forty-seven has removed another of the small company of medical biometricians which lost Dr. Goring in the pandemic of influenza and Dr. R. J. Ewart this year. Maynard did not enter the field of statistics until he had had wide clinical experience, and at the time of his death he was in active medical practice.

The first notable contribution by Maynard to medical statistics was a paper on anti-typhoid inoculation published in the sixth volume of *Biometrika*, and he contributed four other memoirs to that journal, the last of which was published this year. He was the author of three of the memoirs issued by the South African Institute for Medical Research. The first of these, "An Enquiry into the Etiology, Manifestations, and Prevention of Pneumonia amongst Natives on the Rand recruited from Tropical Areas" (November 1913), is perhaps his most important contribution. Apart from the critical appraisement of the value of inoculation, the section of the memoir which examines the evidence in favour of the view that pneumonia is an infectious disease is a strikingly original piece of work.

Maynard was the first writer to propose statistical criteria of infectiousness, and his treatment of "runs" of cases is very suggestive, while his use of time intervals shows that he had grasped a notion which has since been developed by various mathematical statisticians. The joint memoir (with Dr. G. A. Turner) on "Bantu Natives" (1914) is a careful piece of biometry, and the same may be said of his biometric study of the typanosomes of sleeping sickness (1915). Maynard's work on the correlation of the death-rates from cancer and diabetes (*Biom.* vii. 276) was one of the first applications to the problem of cancer of the calculus of correlations and contains a great deal which is valuable and suggestive. As, except during a brief period, his research work was the product of a scanty leisure, and he never enjoyed access to a first-rate collection of statistical literature, the range and accuracy of his contributions are remarkable. His loss, at the zenith of his powers, is a serious blow to science. M. G.

MR. T. F. CHEESEMAN.

BOTANY in New Zealand has sustained a heavy loss by the death of Mr. Thomas Frederic Cheeseman, Curator of the Auckland Museum. Thomas Kirk had been entrusted with the writing of the "Students' Flora" of New Zealand, but it was cut short by his death in 1897. The half-finished volume being brought out by the Government in 1899, was followed in 1900 by a commission to Mr. Cheeseman to draw up a complete flora of the Dominion, at the same time he was set free from his duties of Curator. He had begun his researches in 1870, embracing the whole region from the Kermadec Islands to Otago. The result appeared in 1906, entitled "Manual of the New Zealand Flora," and is regarded by those who have used it, as one of the best local floras in existence. This volume being completed, its author turned his attention to a series of plates in illustration, selected by Mr. Cheeseman, but drawn and lithographed in England under the care of Mr. W. Botting Hemsley, F.R.S., which were worked and sent to New Zealand, where the text was printed, and the book published at Wellington in two quarto volumes.

At the last anniversary meeting of the Linnean Society, the award was made to Mr. T. F. Cheeseman of the gold medal, its highest award, which was received for him by the High Commissioner. It was a matter of the highest gratification when received, but a few months later, news came that his death had occurred in October last, unexpectedly, though he was known to be far from strong. He had read the proof of his revised "Manual" as far as the end of Monocotyledons.

For years Mr. Cheeseman had worked alone, without a botanical companion, his knowledge being entirely due to reading and observation. He was gifted with extraordinary patience, sound judgment, and calm common sense; gentle and lovable, he had a quiet sense of humour, betrayed by the twinkle in his eye. Mr. Cheeseman, who was born in Hull in 1846, had been a fellow of the Linnean Society since 1873.

B. D. J.

WE regret to announce the following deaths:

Canon T. G. Bonney, F.R.S., emeritus professor of geology in University College, London, on December 10, aged ninety.

Lieut.-Col. H. H. Godwin-Austen, F.R.S., on December 2, aged eighty-nine.

Dr. L. Grunmach, a member of the Physikalisch-Technischen Reichsanstalt, Berlin, and Privatdozent in physics at the Berlin Technical College, on October 23, aged seventy-two.

Prof. J. Harkness, Peter Redpath professor of pure mathematics in McGill University, Montreal, aged fifty-nine.

Col. C. Swinhoe, distinguished by his work in entomology, on December 2, aged eighty-six.

Prof. C. C. O. R. Tigerstedt, professor of physiology in the University of Helsingfors, Finland, author of works on the physiology of the blood circulation, on December 2, aged seventy.

Sir Frederick Treves, Bart., formerly Hunterian professor of anatomy and Wilson professor of pathology at the Royal College of Surgeons, Serjeant Surgeon to King Edward VII. and to the present King, on December 7, aged seventy.

Prof. D. T. Wilson, since 1903 a member of the department of astronomy of the Case School of Applied Science, Cleveland, Ohio, who was known for his work on the perturbations of the minor planets, on October 12, aged sixty-one.

Current Topics and Events.

At a very successful dinner given by the Institute of Chemistry at the Hotel Victoria on Monday, December 10, with Mr. A. Chaston Chapman, the president, in the chair, some notable speeches were made relating to the work of chemists, both in times of war and of peace. The dinner marked the 46th anniversary of the foundation of the Institute, and Mr. Chapman rightly stressed the influence which this body has had in promoting a high standard of knowledge and conduct on behalf of its members, and the services it has rendered to the community. The number of fellows, associates, and registered students now reaches a total of more than 5000, so that the Institute may claim to be of real significance to national progress. Lord Haldane, in proposing the toast of the Institute, referred to some of the developments of industry brought about by the applications of science, and he mentioned particularly the establishment and growth of the Imperial College of Science and Technology as a sign of the changed attitude of British people towards science since the days when we let Hofmann go to Berlin instead of retaining him in Great Britain. To the neglect of the vital necessity of science to national prosperity, and to lack of industrial oversight, must be attributed the loss of the coal-tar industry and its related branches. In the early days of electrical engineering also, we let other nations surpass us in the production of machinery and appliances and the employment of electric power, though we were the first to stake out claims in these fields. Though the relation of science to progressive industry is close and effective, almost no reference was made to it in the speeches and addresses with which we have been overwhelmed in the last few weeks through the General Election. The late Lord Salisbury once lamented that, while the work of the statesman, the politician, the soldier, or the leader of men, however great and however fortunate, is of necessity but transitory—what is accomplished by one man being undone by another—the work of the scientific discoverer or inventor has a permanent place in civilisation. Lord Haldane expressed the hope that, as a result of the Election, Parliament will be more interested in the diffusion of knowledge than Parliaments have been in the past, and we trust that whatever party takes the reins of Government in hand will remember that creative science may be made a most potent means of growth of the manufactures and trade of a modern state.

A lecture on "The Application of Science to the Fishing Industry," delivered by Prof. Stanley Gardiner at the Leeds Fisheries Exhibition in September last, has been printed and distributed. It is, primarily, a good account of the points of contact made between science and the fishing industry, and secondarily, a candid criticism of the trade. The author criticises the trawling gear, the handling of the fish, the methods of preserving the fish and the business enterprise of the trawler owners. There are fish near our coasts, he says, which we do not know how to catch. The "Scotch-branded salt herring" is described as "an appalling product, the world's taste for which has assuredly passed." But in 1913 we exported nearly 9 million cwt. of cured herrings, while we imported only about 900,000 cwt. of all kinds of canned fish, salmon included. The fact is that no way of dealing with the enormous potential catch of herrings is practicable except that of curing in salt. The next kind of cured fish that is condemned is the "Newfoundland air-dried salt cod" (much of which comes from the Scottish north-east coast). It would be as easy, the author says, to pack and export this fish brine-frozen; and doubtless it would, but for the very great difference in cost between the very cheap air-drying and the very expensive brine-freezing, to say nothing of the additional cost of transporting and refrigerating the whole cod. The methods of the canners are criticised; thus the author has "failed to discover any British-canned, smoke-cured haddock"; though these were certainly on the market in 1919. The importance of finding the plankton contents of the water as a guide to the place where to shoot herring nets is urged on the experienced skippers of drifters; but though this is sound enough from a scientific point of view, we are not surprised to learn that practical fishermen are "left cold" by scientific work of this kind. It is doubtful whether such criticism, however friendly, is the best way to persuade fishermen and trawler owners of the helpfulness of scientific research.

At a meeting of the Optical Society, held at the Imperial College of Science and Technology, South Kensington, on Tuesday, November 27, Dr. M. von Rohr, of Jena, delivered the 1923 Thomas Young oration. The date was the 123rd anniversary of the delivery by Thomas Young of his famous Bakerian lecture "On the Mechanism of the Eye." The subject of the oration was "Contributions to the history of the spectacle trade from the earliest times to Thomas Young's appearance." The lecturer divided the subject chronologically into six parts. The first period beginning in the 13th century extends to the invention of printing, about 1448; comparatively few spectacles were then in use. The second period, relating principally to the growth of the South German spectacle factories from about 1450 up to 1620, is much better known. At about the same time Venice must have been another important centre of spectacle manufacture, for in the early days of the telescope (the Dutch form and the terrestrial telescope, both made of single, unachromatised lenses) Venetian craftsmen were supplying these instruments; but of Venetian spectacles proper only some casual hints are ascertainable. In both these centres "near" spectacles (for reading and working only) were made. Notable developments took place in Spain from about 1560 up to 1710: distance-spectacles fastened to the head were worn everywhere, even in the highest circles of Spanish aristocracy, and were introduced to China and Japan by Spanish Jesuits. The chief development between 1640 and 1740 was the production of cheap nose spectacles in Nuremberg. The spectacle grinding optician arose in the 18th century. The

greater accuracy indispensable with achromatic objectives (invented by Chester Moor Hall in 1733 and put on the market by John Dollond after 1758) placed the London spectacle maker proper on a much better footing than his Nuremberg competitor working with bad tools and to a very small degree of accuracy.

Mr. A. Bachellery, the Chief Engineer of the French Midi Railway, read a very interesting paper on the electrification of this railway at a joint meeting of the Institution of Electrical Engineers and the Société des Ingénieurs Civils de France (British Section) on November 22. The Midi Railway of France extends in the southernmost part of that country from the Atlantic Ocean to the Mediterranean along the snow-covered Pyrenees, sending off branch lines up most of the valleys of that chain of mountains. In France the standard type of traction current is direct current at 1500 volts, and the standard type of primary current is three phase at 50 frequency. The electric energy is produced at two hydro-electric stations, in one of which the water has a fall of 2300 ft. The pressure is generated at 60,000 volts, but for long-distance transmission it is converted to 150,000 volts, which is the highest pressure used in Europe at the present time. The economies effected by the use of electric traction are notable. The hydro-electric energy is much cheaper than the corresponding energy obtained from coal. Substantial economies on engine shed and repair shop expenses have been effected by electrification. The steep grade on the Bayonne to Toulouse line which took a steam locomotive 34 minutes to climb is now climbed in 13 minutes. The railway company also finds it very profitable to supply electric energy to villages in the neighbourhood of the transmission lines. It intends to electrify 2000 miles of road. The Paris-Lyons-Mediterranean and the Paris-Orleans companies are also electrifying 3800 miles of line. The latter company is constructing a 300 mile 150,000 volt line from the Dordogne power plants to Paris. It will be seen that main line electric traction is making satisfactory progress in France by standardised methods. The English traction engineers who spoke in the discussion agreed practically with the author's conclusions. We have reasons for believing that, before long, main line electric traction in Great Britain will make considerable advances.

As a result of the fire which followed the great earthquake in Japan on September 1, nearly the whole of the collection, amounting to 700,000 volumes, in the library of the Tokyo Imperial University was destroyed. We are glad that an organised effort is to be made by the British Academy to repair this loss. At a meeting of representatives of learned societies, publishing houses and other bodies concerned with the publication and use of books, held on Monday, December 10, at the Royal Society, with Lord Balfour, as president of the British Academy, in the chair, an executive committee was appointed to organise the collection of works for the restoration of the Library. In a letter to Sir Israel Gollancz, secretary of the British Academy, the president of the Tokyo Imperial University states that most of the works destroyed belong to the domains of literature, philosophy, commerce, statistics, and similar departments of the humanities and social science. The Institutes of Physiology and Pharmacology have also lost nearly all their books, but no reference is made by the president to the position of other science libraries, so that we hope it may be assumed that they have, in the main, escaped damage. The vice-chancellors of British universities have already taken some steps towards the supply of books for the Tokyo Imperial University Library, but the appeal to be made by the British Academy will no doubt reach a much larger circle of sympathisers, and we are sure that all British learned institutions, as well as numerous individuals, will respond generously, in money or suitable literary gifts, to the effort to be made to repair the immense losses which the University has experienced.

During the coming season the work of the British School of Archæology in Egypt at Qau will be continued. In particular, search will be made for the source of the ancient human remains, found last year by Mr. Brunton, which are held to belong to the Palæolithic Age. Further explorations will be carried out in the cemetery in which the oldest Coptic MS. of St. John's Gospel was discovered, and the prehistoric cemeteries to the north will be worked in the hope of further discoveries of the ripple pottery and its associated styles. The papyrus of the Gospel of St. John has now been completely opened, photographed, and mounted. It is not only the oldest Biblical Coptic MS., but it is older than any Greek MS. of the Gospel with the exception of the Vatican MS. It is to be edited as a publication of the School by Sir Herbert Thompson, while the manuscript itself is to be placed in the collection of the British and Foreign Bible Society.

News from the Norwegian expedition in the *Maud*, which is drifting across the Arctic Ocean, has appeared in the *Times*. The reports were sent out by the *Maud's* wireless installation and received by the Spitsbergen Radio station. In March 1923 the *Maud* was in lat. 74° 2′ N., long. 170° 20′ E., and was drifting north-west. In September its position was lat. 76° 16′ N., long. 163° 30′ E., when a long-continued north-west gale set in and drove the ship and pack-ice towards the south, with a result that in the end of October it was in lat. 75° 10′ N., long. 159° 30′ E. The current in that part of the polar basin is reported to be from the north-north-east, thus disposing of the likelihood, which was never strong, of extensive land to the north-east of the De Long islands. The *Maud* would appear to be drifting towards the New Siberia Islands, and if it should succeed in passing to the north of that group, will traverse an interesting and unknown part of Arctic Seas, but there is little prospect of the drift taking her to a high northern latitude. Conditions proved unfavourable for the use of the aeroplane. Throughout the summer, there was much mist and the temperatures were low. The floe offered few safe landing-places. Several trial flights were disappointing, and the last one resulted in serious damage to the aeroplane. Scientific

observations from the ship, especially current measurements, have been continued. Captain Wisting reports the death of Mr. Syvertsen, the ship's engineer.

It is announced in the *British Medical Journal* that the French Minister of Public Instruction has introduced a bill for the purpose of awarding to Madame Curie a pension of 40,000 francs per annum, in recognition of her scientific work. It is proposed that the pension shall be conferred on December 28, the twenty-fifth anniversary of the announcement of the discovery of radium by Madame Curie and her late husband.

The annual Exhibition of Scientific Apparatus organised by the Physical Society of London and the Optical Society will be held at the Imperial College of Science, South Kensington, on Wednesday and Thursday, January 2 and 3. The Councils of these Societies invite members of the Faraday Society to attend the Exhibition. Admission is by ticket only, for which application must be made to the Secretary of the Faraday Society.

A Cotton Research Botanist is required at Lyallpur, Punjab, by the Indian Central Cotton Committee, whose duties will consist of investigations with a view of improving local and American cotton schemes. Candidates should possess high qualifications in cotton-breeding and plant-physiology, and apply, with full particulars of age, education, training, and experience, by, at latest, December 24, to the Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1.

At the request of the Local Committee arranging the meeting of the British Association at Toronto next year, the Council of the Association has changed the date of the meeting from September to August 6-13. The main party will leave England about July 25; and the excursion tour will be after the meeting instead of before it. The new arrangements will, we believe, be preferred to the old by most of the members who propose to attend the meeting, which is likely to be large and successful, as many members of the American Association also intend to take part in it. The British Association will meet in Southampton in 1925, and has received an invitation from the University and city of Oxford to meet there in 1926, which will in due course be presented to the general committee.

The gold medal of the Royal Scottish Geographical Society has been awarded to Dr. Hugh Robert Mill, and the Livingstone gold medal to Dr. Marion I. Newbiggin, in recognition of their distinguished service in geographical research and exploration. In presenting the medal to Dr. Mill, Lord Salvesen, president of the Society, referred to some outstanding points in Dr. Mill's career. For eighteen years he was chairman of Trustees and Director of the British Rainfall Organisation and editor of "British Rainfall" and *Symons's Meteorological Magazine*, while for seven years he was one of the British representatives to the International Council for the Study of the Sea. He has made noteworthy contributions to geographical research and literature. Referring to Dr. Newbiggin, Lord Salvesen spoke of her services as editor, since 1901, of the *Scottish Geographical Magazine*, and of her many works on biological and geographical subjects.

The first Experimental Report to the Atmospheric Corrosion Committee of the British Non-Ferrous Metals Research Association will be presented and discussed at a meeting of the Faraday Society to be held on December 17, at 8 P.M., in the rooms of the Chemical Society, Burlington House, W.1. The very comprehensive series of field tests and laboratory experiments described in the Report were carried out by Mr. W. H. J. Vernon on behalf of the Committee. Persons interested in the subject desirous of attending the discussion may obtain a ticket of admission from the secretary of the Faraday Society, 10 Essex Street, London, W.C.2.

At one time planters were usually at least part owners of the estates that they cultivated, but now most of them are simply salaried employees of London companies. In the report of a sub-committee appointed by the Incorporated Society of Planters upon salaries, general conditions and terms of service on rubber estates in the Malay Peninsula, etc. (Kuala Lumpur, 1923), the rubber planters of Malaya, a numerous body of Europeans, suggest the restoration of the old rate of pay (reduced during the recent slump), and the granting of leave as in Government service at a definite rate, with free passages home for planter, wife, and children. The climate is trying, leave every few years is needful, and cost of travelling has greatly increased. If the prestige of the white man is not to suffer, and the quality and efficiency of the planters to be kept up, something must be done to improve the present conditions.

A paragraph has recently appeared in the technical press referring to a violent explosion which set fire to and sank the British steamer *Otterburn*. The paragraph stated that the disaster was thought to be due to the explosion of barrels of chlorate of potash. Mr. W. J. U. Woolcock, general manager of the Association of British Chemical Manufacturers, informs us that there appears to have been no chlorate of potash on board the ship, but that there was a parcel of chloride of potassium. The transport of dangerous substances is always a matter of difficulty, and it is particularly undesirable that the difficulties should be added to by blaming unnecessarily what is known to be a dangerous substance.

The Scientific Novelties Exhibition last year in aid of King Edward's Hospital Fund for London, at King's College, Strand, W.C. 2, proved so successful that a similar exhibition has been organised for the approaching Christmas vacation. Demonstrations and experiments illustrating modern scientific discovery and research will be in progress 2-5 P.M. and 6-9 P.M. daily throughout the period when the Exhibition is open, December 29-January 9. In addition, a number of distinguished scientific workers are giving their services as lecturers. Every day there will be four or more lectures; among the subjects dealt with in this way are: tuning forks, Egyptian mummies, flame, acoustics of buildings,

atoms and electrons, muscular exercise, giant and dwarf stars, monkey glands, the Himalaya, astronomical evidence bearing on Einstein's theory, the fuel of the future, and new uses of silica in industry. The full time-table of lectures and tickets in advance can be obtained from the secretary of King Edward's Hospital Fund for London, 7 Walbrook, E.C. The unusually wide scope provided by the lectures and demonstrations in both pure and applied science, and the authority given by the names of the lecturers and those associated with the Exhibition, should prove an attraction which it is to be hoped will be of even greater financial assistance to the hospitals of London than the Exhibition of last year.

November was abnormally cold this year in many parts of England, and in places the month was said to be colder than any previous November on record, a feature perhaps greatly due to the short period of observation. Using the meteorological observations at Greenwich Observatory for the civil day, published by the Registrar-General in his weekly return, and comparing with similar observations available from 1841, it is seen that the month's temperature was not unique. The mean temperature for the month was 38·8°; since 1841 there have been three years, 1851, 1871, and 1879, with a lower mean than November this year; the lowest was 38·0° in 1871. The mean of the maximum or day readings was 44·2°; since 1841 there have been three Novembers with a lower mean maximum, in the years 1871, 1879, and 1919, and the lowest was 43·2° in 1871. The mean of the minimum or night readings was 33·3°; there were also three years, 1851, 1871, and 1910, with a lower mean minimum than this year; the lowest was 32·4° in 1851 and 1910. The lowest shade temperature in November was 22·7° on November 26 and 23·4° on November 8; there have been ten Novembers since 1841 with a lower temperature, but only two with a temperature below 20°; the lowest was 18·3° in 1890. The lowest radiation temperature at Greenwich in November this year was 14·0° on November 12 and 14·1° on November 8; there have only been five Novembers since 1856 with a lower radiation temperature; the lowest was 9·1° in 1908.

A dispatch from the Belgrade correspondent of the *Times* published on December 6 records some interesting discoveries at Doiran and Mitrovitsa. At Doiran, the ruined town situated on the lake of the same name, which formed part of the Bulgar front line in Macedonia during the War, workmen have brought to light large columns of white marble, presumably part of a temple, well-preserved marble tablets with finely carved reliefs of the heads of six Greek gods, a quantity of coins, and a vase so large that two men can stand in it with ease. This last should be comparable with the enormous Græco-Roman vase found on the Struma, which stood in the gardens of the French Military Club at Salonika in the latter years of the War. At Mitrovitsa two Roman graves were found on the site of the old Roman Sirmium, once the metropolis of Illyricum. Of these, one contained the sarcophagus of a girl of 14 years of age. The bust of the girl and her brother are represented in relief. The names in the Latin inscription suggest that the girl was a Pannonian, possibly living under the Emperor Marcus Aurelius in the third century A.D. The sarcophagus had evidently been plundered and contained nothing but the skeletal remains.

Our Astronomical Column.

Recovery of D'Arrest's Comet.—This periodic comet was not seen at the 1917 return, and experienced large perturbations by Jupiter in 1920 (minimum distance from Jupiter 0·50). Two nearly identical computations of the perturbations were made: (i.) by Mr. F. R. Cripps, (ii.) by A. Dubiago and A. Lexin of Kasan. Their respective dates of perihelion were 1923, Sept. 14·12 and Sept. 14·715; the other elements of (ii.) were ω 174° 1·5′, Ω 143° 31·7′, i 18° 3·9′, ϕ 38° 1·1′, μ 534·783″, equinox 1925·0.

In spite of these accurate forecasts, search was vainly made for the comet during July, August, and September. However, on Nov. 10 at 11^h 50^m S.A.S.T., Mr. William Reid, of Rondebosch, Cape Town, well known for his cometary discoveries, found a comet the approximate position of which was R.A. 21^h 30^m, S. Decl. 28° 30′. His description was: "Fairly large, very faint, slightly brighter in middle, no nucleus. It appeared like a faint star-cluster with many stellar points." A position on Dec. 1 at 9^h 21^m G.M.T. was telegraphed: R.A. 22^h 39^m 32^s, S. Decl. 25° 16′.

These positions leave no doubt that the object is D'Arrest's Comet, which has presumably brightened physically since the summer. The date of perihelion deduced from the observations using elements (ii.) is Sept. 15·15 G.M.T. The following ephemeris is for Greenwich midnight:

	R.A.	S. Decl.	log r.	log Δ.
Dec. 16.	23^h 22^m 16^s	21° 36′	0·2304	0·2000
,, 20.	23 32 48	20 33	·2369	·2147
,, 24.	23 43 16	19 29	·2436	·2293
,, 28.	23 53 12	18 24	·2500	·2435
Jan. 1.	0 2 56	17 20	0·2565	0·2576

As the distances from sun and earth are rapidly increasing, the comet is not likely to be seen for long. Its recovery is a matter for great satisfaction, as it was in danger of being permanently lost. The present observations will enable accurate predictions to be made for the next two apparitions; the Jupiter perturbations are small in the revolution now commencing.

Interesting Cepheid Variable.—Señor Comas Sola, of Barcelona, discovered, in April last, an interesting variable star in R.A. 15^h $14{\cdot}2^m$, S. Decl. 8° 11′. Harvard College Observatory Bulletin 791 describes a photographic study of the star, which shows that it is a periodic variable with sharp maxima, the period being approximately 0·369 day. It is a Cepheid of the "cluster" type; the extreme range of magnitudes is from 10·8 to 12·5, which is noted as larger than usual for this type. The Bulletin gives a series of suitable comparison stars for the variable, the magnitudes of which are from 7·8 to 12·8. The galactic co-ordinates are 322° +38°.

Research Items.

JĀBIR IBN HAYYĀN.—In a paper in the Proceedings of the Royal Society of Medicine, 1923, vol. 16 (section of the History of Medicine), p. 46, Mr. E. J. Holmyard has collected the information we possess relating to Jābir ibn Hayyān, the most celebrated chemist of Islam. He appears to have lived during the latter half of the 8th century A.D. His birthplace is unknown, but he lived at Kūfa for at least part of his life, perhaps also at Bagdad. He was a voluminous writer, but most of his works are lost. Mr. Holmyard gives a list of the works of Jābir ibn Hayyān, with ninety-two titles. Whilst primarily a chemist, he wrote also on medicine, geometry, astronomy, philosophy, optics, and poetry, was interested in mysticism, and his writings show that he was a man of fine intelligence. The chemical writings indicate an extensive practical knowledge of the usual chemical operations, which he attempted to explain, and the theory of the composition of metals from sulphur and mercury found in the Latin writings of "Geber." Mr. Holmyard leaves open the difficult question as to the identity of the latter with Jābir ibn Hayyān, but he shows conclusively that the arguments so far adduced to prove the contrary are often incorrect and are wholly inadequate.

PINK AND BLUE FLOWERS.—Dr. W. R. Gelston Atkins has a very interesting contribution to the problem of colour in flowers in a paper upon the pink and blue flowers of the Hydrangea in the Scientific Proceedings of the Royal Dublin Society, vol. 17, pages 201-210. It appears that the pink form is usually found in soils with a P_H of 6 or more. Above P_H 7·5, pink flowers appear to be the rule, while blue flowers predominate in more acid soils. Examination of the flowers shows that difference in colour is not due to a difference in reaction of the flowers themselves, but experiment showed that pink flowers contain far less iron than blue ones. In the more alkaline soils ferric salts are no longer available to the plant, and Dr. Atkins's work seems to give good grounds for thinking that difference in colour of these flowers depends in some way upon the greater availability of the iron to the plants growing in the more acid soils.

PLANT PHYSIOLOGY AND VITALISM.—Prof. Walter Stiles, of Reading, makes a brief contribution from the point of view of the plant physiologist to the discussion in progress in the pages of *Scientia* for November upon the subject of vitalism and mechanism. His main theme appears to be that both morphology and physiology seem to be in agreement at the moment that the most hopeful line of attack upon the problem presented by the form and structure of the organism is along the lines of development. The species may be regarded as a special physico-chemical aggregate of substance which provides a definite range of possibility in the final form and structure of the mature organism, depending upon conditions both external and internal prevailing during its development. Engaged in the task of tracing the connexions between this original species substance, the conditions under which it develops and the structures to which it gives rise, physiology is so far from having solved even its most immediate problems, even in those cases where there is little reason to doubt that greater understanding will show that a physico-chemical explanation is adequate, that it has as yet paid little attention to the more abstract question as to whether a closer acquaintance with the complexity of the living organism will find the machinery of physics and chemistry insufficiently resourceful.

THE PAMIR EARTHQUAKE, 1911.—In a paper recently published in the Quarterly Journal of the Geological Society (vol. 79, 1923, pp. 237-245), Mr. R. D. Oldham urges that the Pamir earthquake of February 18, 1911, was the cause and not, as the late Prince Galitzin considered, the result of the great landslip which occurred at the same time (NATURE, vol. 111, p. 682). The disturbed area of superficial earthquakes, as in the Ischian earthquake of 1883, is always small; that of the Pamir earthquake was more than 200 miles in diameter, while the region of destructive intensity was at least 40 miles in length. The earthquake was followed by after-shocks, and numerous landslips occurred in other parts of the central district. Moreover—and this is the most important point—the great landslip occurred close to the east end of that district. Mr. Oldham thus concludes that the earthquake was of deep-seated origin, though he regards it as possible that the unusual development of the surface waves may have been due in part to the landslip.

COMAGMATIC REGIONS AND WEGENER'S HYPOTHESIS.—Prof. H. S. Washington has completed his studies of the lavas of the Hawaiian Islands by an account of the succession of olivine-basalts in Kilauea, and by a general summary of his analytical results (*Amer. Journ. Sci.*, vol. 206, p. 338, Oct. 1923). The inclusions brought up from the depths are lumps of peridotte and picrite, and nothing whatever has been found to justify Wegener's suggestion that the Pacific volcanoes are built over residual crust-blocks left behind by drifting continents. Prof. Washington directs attention to this point in a paper on "Comagmatic Regions and the Wegener Hypothesis" (Journ. Washington Acad. Sci., vol. 13, p. 339, 1923), and he cites a number of cases in which the igneous rock-types, in districts regarded by Wegener as having been formerly united, differ markedly on opposite sides of the Atlantic. The Triassic plateau-basalts of the later Karroo series resemble those of S. America, from Brazil to Argentina; but such islands as occur in the S. Atlantic contain sodic and not sodic-calcic (basaltic) lavas (p. 346). An example of two identical comagmatic regions, separated by oceanic waters, appears in the description of "The Dolerites of King George Land and Adelie Land," by Dr. W. R. Browne (Australasian Antarctic Exped., Sci. Rep., Ser. A, vol. 3, pt. 3, 1923). The resemblance between the igneous series in Tasmania and that in the region due south of it in Antarctica appears to be complete. Prof. Washington has sought such identity in vain in his study of the opposed coasts of the North Atlantic.

WEATHER OF AUSTRALIA.—A report of the Meteorological Service of the Commonwealth of Australia has just been issued for the year 1921–22 by Mr. H. A. Hunt, the Commonwealth Meteorologist. Like many other meteorological and scientific establishments in different parts of the world, the funds available for the work are not sufficient to allow of desirable and much needed extension. The author has pointed out the direct monetary value derived by the general public and special trades and employments from the

activities of the Weather Bureau and its weather forecasts. There are many industries helped by rainfall, while others are hindered. Weather changes such as heat and cold, fog, hail, and squally conditions are referred to as influencing general trade and journeyings. In confirmation of good work done, reference is made to the death roll of the pearling fleet in Western Australia; the lives lost in 1887 numbered 200, while in 1910 the deaths had decreased to 40. For the improvement of flood and storm warnings as well as the ordinary forecasts for the general public, reports are badly required from more land stations as well as from ships at sea. The Government Meteorologist deplores the want of funds for the purchase of instruments required for observational work. Data are available for aviators, but funds are required for their publication, and tracks of hurricanes and storms in Australia and the neighbouring sea, in the South Pacific, for which data exist, require printing for the guidance of navigators. There are 484 climatological and 5922 rainfall stations distributed throughout the Commonwealth and the immediate neighbourhood. Pilot balloon ascents for upper air research during the year numbered 1049; the observations show great turbulence of the atmosphere in the Melbourne region, owing to Melbourne being situated largely in a basin, almost surrounded by hills.

New Dissecting Microscope.—Messrs. R. and J. Beck, Ltd. (Cornhill, E.C.3), have submitted one of their crescent dissecting microscopes for our inspection. The base consists of a heavy crescent-shaped casting with a central pillar for the lens and end-pieces supporting the hardwood hand-rests and thick glass stage. The lenses, which may be either simple or achromatic, are carried in a swinging arm fitted to a solid rod which moves up and down the central pillar by a rack and pinion for focussing, the milled head actuating this being set at a convenient angle. The range of motion is more than three inches. Below the stage and swinging in gimbals is a mirror, one surface of which is silvered; the other is of opal white glass. The hand-rests are very comfortable and the whole instrument is very stable, so much so that it can be used as a compound microscope by attaching a microscope body to the swinging arm.

Action of Sodium Arsenite on Photographic Plates.—When commercial sodium arsenite is applied to a photographic plate it renders it developable, and so, apparently, produces the same change in it as exposure to light does. Lüppo-Cramer suggests that the change is of the nature of the production of traces of an unstable complex, which provides the necessary starting places for initiating the action of the developer. Mr. Walter Clark of the British Photographic Research Association maintains that this suggestion is wrong and that the evidence which he brings forward in a recent communication (*British Journal of Photography*, November 23) is in favour of his contention that the developable condition is brought about in this case by the action of the arsenite "on material other than silver bromide which is present in or adsorbed on the silver halide grain." Mr. Clark finds that a preliminary treatment with chromic acid "lowers to an enormous degree the sensitivity of a plate to arsenite solution," and argues that the formation of complexes would not be affected by this treatment. He finds that sodium arsenite of the formula $NaAsO_2$ (or NaH_2AsO_3) does not react with silver bromide; he gives the characteristic curve produced by treating the plate with the arsenic solution for increasing times, the equivalent of increasing exposures to light, and other interested details connected with this subject.

Müller X-ray Spectrograph.—The now numerous applications of X-ray spectrometry are provided for in a new X-ray spectrograph designed by Dr. Müller and constructed by Messrs. Adam Hilger, Ltd. (75a Camden Road, N.W.1). The instrument is described in a pamphlet of a scientific quality and accuracy which merit high praise. Dr. Müller's instrument is of simple design, and possesses an accuracy sufficient for the great majority of work. It provides for the oscillation of the crystal by means of a clockwork motor, the normal working conditions being about 40 oscillations per hour through an angle of about 12°. Insulated levelling screws and a protective lead screen are provided. The spectrograph is available for any of the three standard methods. For the Bragg method (single crystal) the slit consists of two brass blocks 26 mm. long, which are clamped at a known distance apart. The plate holder is designed to take plates $4\frac{3}{4}$ in. × $\frac{3}{4}$ in. For the Debye method, a powder holder is mounted in place of the crystal carrier. The slit is replaced by a brass block containing a circular aperture 1 mm. in diameter, which points at the powder holder and fits into an aperture of a circular camera, 6 cm. in diameter, bearing a photographic film. A small further change makes the instrument suitable for taking photographs by Hull's method for powders. The spectrograph should prove very useful to crystallographers for information on lattice structure, to chemists for analysis of materials used as X-ray targets, to metallurgists for the investigation of the crystalline structure of metals and alloys, and to radiologists for measuring X-ray wave-length and composition.

Luminescence of Boron Nitride and Calcium Tungstate.—Under certain conditions of preparation boron nitride lights up when brought into contact with the edge of a flame, and fluoresces in the same spectral region under the action of cathode rays. Herr E. Tiede and Frau H. Tomaschek describe experiments in the *Zeitschrift für Elektrochemie*, July 1, 1923, which show, first, that the methods of preparation which give active material are those which favour the crystallisation of the boron nitride, and second, that an examination of active and inactive material, by the Debye and Scherrer X-ray method, proves that the active material is crystalline, while the inactive is amorphous. The first of these authors and Herr A. Schleede describe experiments with calcium tungstate, very pure specimens of which may give intense blue fluorescence under the action of X-rays, with no trace of phosphorescence afterwards. A minute amount of impurity reduces the fluorescence, and produces phosphorescence, the intensity and period of which is strongly influenced by the nature of the impurity and the method of preparation, as in the case of the sulphide "phosphores." The fluorescence depends on the temperature at which the substance is prepared, no effect being produced with cold preparations, and the intensity increasing up to the highest temperature used, 1100° C. An X-ray examination showed that the active material was crystalline, the interference lines becoming more and more marked as the temperature of preparation was raised. An old specimen, prepared in the cold three years ago, which originally showed no fluorescence, was found to fluoresce strongly, and when submitted to X-ray examination proved to be strongly crystalline.

Loud-speaking Telephones.

The Institution of Electrical Engineers and the Physical Society of London had a joint meeting on November 29—Dr. Alexander Russell, the president of both societies, being in the chair—to discuss the problems connected with "Loud-speakers for Wireless and other Purposes." The meeting aroused extraordinary interest owing to the popularity at the present time of loud-speakers in connexion with broadcast reception, and several hundreds of members were unable to obtain admission into the lecture theatre of the Institution of Electrical Engineers.

Prof. A. O. Rankine discussed the general principles involved in the accurate reproduction of sound by means of a loud-speaker. He pointed out that there has been a sudden great public demand for a good instrument, and that the solutions given have practically all been obtained by the method of trial and error. Stated roughly, the problem is how best to secure that sounds emitted in one place may be a sufficiently faithful copy of sounds emitted in another.

The difficulty of the problem lies in the fact that the reproduced sounds must be of considerable intensity. If we are content with feeble intensity in reproduction there are already available sufficiently good loud-speakers. It appears on theoretical grounds that to procure reproduction absolutely perfect in the physical sense—as distinct from the acoustical—is not feasible owing to the variety of transformations necessary in practice.

There is first the amplification of the electrical fluctuations; in the second place, there is the process whereby the current excites corresponding variations of air pressure; and thirdly, there is the treatment of the aerial vibrations after they have been created. So far as the amplification of the electrical waves is concerned, it is found that the more thermionic amplifiers used the more difficult it is to get exact reproduction. The second question, the transformation of a portion of the electrical energy into sound energy, is a very wide one. It may be transformed by electromagnetic, electrostatic, or thermal means, and each method provides a different field for investigation. Lamb has stated that the simple harmonic type of vibration has the pre-eminent position in mechanics because it is the only type which retains its character absolutely unchanged when it is transmitted from one system to another. We can conclude, therefore, that sounds cannot in general be reproduced with perfect precision. All that can be done is to avoid too great changes in the character of the vibrations. Scientifically it is convenient to dissect these vibrations into their harmonic components.

In aiming at loudness there is a temptation to resort to resonance effects in order to secure it. For example, in the majority of telephone diaphragms there are natural frequencies within the frequencies of the sounds used. The corresponding components therefore get preferential treatment. This can be remedied to a considerable extent by damping the diaphragm, but unfortunately this reduces its general sensitivity. An alternative plan is not to reduce resonance but to confine it to values beyond the upper limit of audibility, or at least as far in that direction as practicable. Another plan is to choose mechanisms of very low natural frequencies, but there are theoretical reasons for considering this method not so desirable.

The method is used, however, in a device perfected by Siemens and Halske. It consists of a strip of thin metal foil suspended between the poles of an electromagnet as in the Einthoven galvanometer. The plane of the foil is parallel to the magnetic field, and the incoming telephonic current flows through the foil. This responds by mechanical movements perpendicular to its plane, and is the equivalent of the ordinary telephonic diagram. Its fundamental natural period is two seconds, and it is said to operate without a horn.

In Prof. Rankine's opinion, horns should, whenever possible, be dispensed with owing to their resonant character. The ideal sound resonator would be spherical in shape and excited in such a way that it imparts to the neighbouring air symmetrical fluctuations of pressure. For speech transmission, all room reflections should be damped out both at the sending and at the receiving stations. A large number of listeners, however, appear to be asking for echo effects. In his opinion, when loud-speakers are used, echoes and reverberations should be eliminated at least at one end. In broadcast opera, where transmission already unavoidably has this effect, the listening room should be draped much in the same way as the transmitting room usually is draped.

Prof. C. L. Fortescue considered that, with properly designed valves, no serious distortion was due to the amplifier. In the later stages of the amplification, however, it is necessary to use valves having a considerable power output.

Mr. E. K. Sandeman gave a valuable demonstration of the relative importance of each frequency region in the audible spectrum. By suitable wave filters he cut off all the vibrations with frequencies less than 500 transmitted to a loud-speaker. He showed that the effect on the intelligibility of the speech transmitted from another room was not appreciable, but the "naturalness" of the speech was notably impaired. When all frequencies greater than 1700 were eliminated by filters, the speech was scarcely intelligible. This might be considered as the lowest limit for commercial speech transmission. He proved that the intelligibility was much the same when all frequencies above 1500 were cut off as when all frequencies below 1500 were cut off. Simple and interesting methods of testing speech transmission were given.

Dr. W. H. Eccles compared the advent of broadcasting news and speeches in the history of the world to the advent of the printing press. Whether for good or ill, it had come to stay. Loud-speakers could be used to broadcast political speeches to very large audiences. He mentioned a case in America where a speaker was plainly audible, by means of these devices, to an audience of 700,000.

Mr. G. A. Sutherland, who discussed "auditorium acoustics and the loud-speaker," pointed out that uniform loudness is associated in practice with the absence of curved walls. Curved walls always produce main and subsidiary foci, and are a menace to good acoustics. More satisfactory hearing is likely to be obtained by distributing an audience into a number of small rooms with a loud-speaker in each than by attempting to accommodate them all in a large hall. The presence of an audience is very effective in reducing reverberation. A sure indication that a room is suffering from excessive reverberation is given when increasing the loudness of the sounds increases the distortion. When a loud-speaker is too rich in higher-pitched notes the presence of a large audience has a corrective effect.

Mr. S. G. Brown gave a successful reproduction, by means of his "Frenophone," of a portion of an opera that was being broadcasted by 2LO, the London Broadcasting Station. This instrument has

a rotating glass disc and a steel-backed cork pad which rests in contact with its surface. The cork is linked to a loud-speaker movement, and a telephone receiver presses on the back of the cork. The frictional drag thus varies and works the device.

Capt. Eckersley exhibited a French loud-speaker which gave very satisfactory reproduction. He said that the solution of the problem depended on the loud-speaker at the receiving station. He stated that if properly magnified the signals transmitted by the London Broadcasting Station would give perfectly satisfactory reproduction of speech and music.

Although the meeting started at 5.30 and went on to 9.45, with an hour interval for dinner, the interest of the audience never seemed to flag. The speakers were unanimous in agreeing that the perfect loud-speaker had still to be invented.

Congress of the French Society of Chemical Industry.

"THE exchange of international thought is the only possible salvation of the world," words used by Thomas Hardy, form the text of two recent articles by John Galsworthy in the *Times*. Something more than an exchange of thought internationally is required—close personal acquaintance and direct exchange of opinion are the real needs. It was with this idea in mind that several of us attended the conference of the Société de Chimie Industrielle in Paris on October 21-26—and the game was more than worth the candle, if only as giving the opportunity of appreciating French *politesse* and their incomparable ability as social entertainers. No more is to be said for them than for ourselves as organisers of an effective gathering of scientific workers: they are as unfortunately subdivided in their interests as we are; as little prepared as we are to overcome the evils of the gross specialisation and narrowness of outlook which to-day retard the progress of science within its own ranks and in public esteem. The conference met at the Conservatoire National des Arts et Métiers in fifteen sections, and in each section the programme was disjointed.

The proceedings were opened by a reception on the Sunday evening at the Hôtel Majestic by the president and his wife, M. and Mme. Paul Kestner, a noted name in French chemical industry, which carries us back to the first sulphuric-acid chambers and the discovery of racemic acid, the foundation upon which Pasteur built his colossal edifice. An exquisite musical and terpsichorean entertainment was provided, in which a most refined sense of proportion and sobriety was displayed.

The session was opened on the Monday morning by the president, supported by the Minister of Commerce. An address was then given by M. Menozzi, director of the Agricultural School at Milan. The intention was to make agriculture the primary subject of the conference. After this some of the sections got to work. In the evening, foreign delegates were entertained at dinner by the "Bienvenue Française"—a society which exists with the object of promoting amicable relations between foreign visitors to Paris and the French; the society appears to owe its success largely to Mme. Juvenel, a lady not only full of energy but also gifted with irresistible charm of manner. The dinner was followed by a most perfect musical entertainment in miniature.

On Tuesday there was more sectioning, and in the afternoon a lecture by Prince Giorno Conti on his boric-acid works. Dr. Herbert Levinstein was the chief morning dish—the heroic and collected reader of a long historical statement of the development of the British dyestuff industry, in a French which all the English-speaking members of the audience—who were in the majority—could understand without difficulty. His courage was much admired.

At the closing meeting, on the Wednesday, Sir John Russell gave an address on the relations between the organisms in the soil and its fertility, lecturing with his accustomed fluency; this was much appreciated. In the evening a great banquet was given at the Hôtel Palais D'Orsay.

Thursday morning was spent in visiting the works of M. Potin, who has large grocery stores in Paris, where the fining of *vin ordinaire* is carried out on a large scale. Then the party proceeded to the chocolate works of M. Menier, on the banks of the Marne, where they were entertained at lunch before inspecting the factory. A more perfectly appointed establishment cannot be conceived. On Friday there was an excursion to Rheims. The cathedral was first visited, under the guidance of his Eminence Cardinal Luçon, a man of wonderful vigour though eighty-four years old. In the course of his address, he most solemnly assured us that the cathedral was never used as a post of observation. The manufacture of champagne was then studied in the vaults of Messrs. Pommery and Greno, after which the party was entertained at lunch by the firm. In the afternoon we were motored across the rolling chalk plain on which Rheims is situate to the Hiedsieck vineyard and the Moulin de Verzenay, whence we could see the whole extent of the great battlefield. Much has been done towards restoring the cathedral; the roof is rebuilt, and Rheims itself is half rebuilt. Cathedral and town are a moving spectacle—stark witness of the brutality and barbarism of the German invaders. With such evidence before one, it is impossible not to understand the bitterness of French feeling—to excuse them almost any action in self-protection. Rheims cathedral will long remain a certain proof that the world can never allow German "civilisation" to be the dominant factor. The French are but asking for honourable treatment—for at least part of that which is due to them; but they can obtain no evidence of their enemy's willingness to fulfil his obligations. M. Vidal, the assistant-secretary for technical education, who presided and spoke with wonderful eloquence and convincing sincerity at the Rheims luncheon, was most definite in his assertion that France was entirely pacific in intentions; and the same assurance came from other prominent speakers during the week.

Whatever the value of the meeting in technical respects, socially it was a very great success, and we left it wiser men. French was spoken in many styles, and not a few of our hosts showed themselves to be masters of English; still, the need to cultivate a knowledge of each other's language was ever before us. To think internationally we must understand one another better; true understanding is greatly helped by meetings such as that now described, and it should be regarded as the duty of scientific workers to avail themselves of these opportunities. It is significant that we have a Galsworthy telling us that the future is with science, not to destroy but to save. We need to be up and doing. The public will not come to us, the Press is not with us; it is for us to go forward. The French

are clearly a people of wonderful courage and energy; they are constructive; they are willing to be governed and have a government; the whole nation is at work. The downfall of Germany is due to the destruction of its government: only the appearance of a Bismarck can save it. We may well take warning. We seem to show no constructive power; the politicians are at fault, without imagination, without outlook; our moral attitude towards work, in all classes, is unsound. Unless our science can be made effective we shall soon be nowhere.

HENRY E. ARMSTRONG.

The Present Position of the Ergot Problem.

AMONG well-known drugs, ergot has always occupied a peculiar position. A parasitic fungus, which after many disastrous epidemics was recognised as a scourge, ultimately became the chief medicament of the obstetrician. The numerous attempts of the nineteenth century to isolate its active constituents now appear of little value, but the fundamental discovery by Tanret in 1875 of the crystalline alkaloid ergotinine, $C_{35}H_{39}O_5N_5$, still stands out. Unfortunately this substance does not produce the characteristic effects of ergot to any considerable extent; much later a second alkaloid, ergotoxine, $C_{35}H_{41}O_6N_5$, discovered simultaneously by Barger and Carr in Great Britain, and by Kraft in Switzerland, was, however, found by Dale to have a powerful physiological action, and to produce, for example, the characteristic gangrene. The subsequent discovery, by Barger and Dale, of small amounts of powerfully active, non-specific amines in ergot extracts led some clinicians, particularly in Germany, to substitute these amines for ergot, and to neglect the specific alkaloids.

Attention has been recently again focussed on the latter by A. Stoll, of Basle, who gives in *Die Naturwissenschaften* for August 17 and 24 a résumé of earlier researches and of his own work. In certain varieties of ergot Stoll has discovered two new crystalline alkaloids of the formula $C_{33}H_{35}O_5N_5$. One of these, ergotamine, was found by Spiro to resemble ergotoxine in action, and more recently Dale and Spiro, in a joint paper, declared ergotamine and ergotoxine to be pharmacologically identical. There are therefore no complications on the biological side. Ergotamine can be converted into a less soluble and less potent isomer ergotaminine, which in some respects is analogous to Tanret's ergotinine. Stoll has thus discovered a new pair of alkaloids, showing great similarity to the older pair. The physiologically potent member of each pair has the same action, a finding which, according to Stoll, also results from unpublished experiments of Rothlin. Chemically the new pair are also closely related to the old, by colour reactions, decomposition products, optical rotation, etc. Ergotamine and ergotaminine both differ from ergotinine by C_2H_4, and from ergotoxine by C_2H_6O, the elements of a molecule of ethyl alcohol.

Yet all attempts to convert one pair of alkaloids into the other pair have failed, and for the present they may be regarded as homologues. From some specimens of ergot Stoll obtained only ergotamine, from others only ergotoxine; sometimes both alkaloids were isolated. Yet the identity of the action of these two alkaloids is remarkable, and without parallel among homologues. Are they perhaps both formed from a common precursor by the different methods of extraction employed? Are they perhaps converted into the same active substance in the body? Their puzzling relationship certainly deserves further investigation, which is, however, rendered difficult by the scarcity of suitable material, greatly accentuated by the War.

This seems to be the present position of the ergot question. The résumé under review deals in a useful manner with the older work, and shows how during the last two decades our knowledge of the active principles of ergot has been placed on a solid foundation, largely through English and Swiss work. Most of the investigations of the last century the writer dismisses as valueless. His own important contributions are of the kind we might expect from one who was associated with Willstätter in the study of chlorophyll.

Clothes Moths and their Control.[1]

AMONG entomologists there are well known to be two very common moths the larvæ of which are destructive to fabrics; namely, the case-making clothes moth (*Tinea pellionella* L.) and the webbing clothes moth (*Tineola biselliela* Hum.); the tapestry moth (*Trichophaga tapetzella* L.) is much less frequent but is occasionally destructive. In the case-making clothes moth, the larva makes a portable habitation out of its silk, together with fragments of the material upon which it feeds. It withdraws completely into the case when resting, but when feeding or moving it protrudes its head and foremost body-segments. Pupation also takes place within the case, which is sealed up and anchored to the fabric or other object. The webbing clothes moth is the most abundant species of the three; its larva does not construct a portable case, but spins silken tunnels wherever it crawls over the material which it is consuming. When fully fed it constructs a silken cocoon intermixed with particles of fabric and excrement; this pupal shelter, therefore, is quite different from that of the species previously mentioned. In the rarer tapestry moth the larva constructs silk-lined burrows through the substance of the material which it infests.

In general, the larvæ of clothes moths feed upon wool, fur, feathers, hair, and all fabrics manufactured from them. It will therefore be realised that they may be found attacking not only clothing but also carpets, rugs, furs, upholsteries, stuffed animals, brushes, felts in pianos, and the like. The moths are relatively short-lived; they take no nourishment and are in themselves harmless. Their eggs are laid upon or between folds of fabrics or within the meshes of the latter. They are readily crushed by brushing, etc., and are very fragile. Under average indoor conditions they hatch in about a week, this period being subject to lengthening or shortening according to temperature. The larvæ are relatively long-lived and require from about fifteen weeks to two years to complete their development. Much depends upon the nature of the material upon which they are feeding and the temperature conditions under which they exist. The pupal, or resting, period varies from about eight days in warm summer weather to a month or more in winter. In the British Isles the moths are commonest between June and October, and their larvæ are feeding the great part of the remainder of the annual cycle.

Methods of dealing with these pests are numerous. Fabrics that are well brushed or beaten every two weeks are seldom seriously affected: exposure to

[1] Clothes Moths and their Control, by E. A. Back. U.S. Dept. of Agric. Farmer's Bull. 1353, July 1923. 28 pp. with 21 figs.

direct sunlight is also a valuable measure. Articles of clothing that require to be stored are immune from attack if sealed down in paper bags, or very securely wrapped in several layers of quite unbroken newspaper. Naphthalene, in the form of flakes or balls, should be placed among the clothing thus fastened up. It also acts as a deterrent when placed in drawers or cupboards, but is not entirely effective under such conditions. Paradichlorobenzene appears to be as valuable as naphthalene, but camphor is decidedly less effective.

On a large scale, the cold storage of furs, carpets, and furniture is the most certain of all preventives, and this method is coming more and more into use. Extensive infection of carpets, upholsteries, etc. in large houses, hotels, etc. may need fumigation in order to eradicate clothes moths completely. An effective remedy, which is also non-injurious to furniture, fabrics, plate, or other household goods, is the application of hydrocyanic acid gas. Its manipulation requires the services of an intelligent person who understands the dangers of its use and knows how to administer it. Carbon tetrachloride is also effective, and has the advantage over hydrocyanic acid gas in being neither explosive nor inflammable. Fumigation with sulphur is a well-known remedy, but there is some danger from fire in its application, while it has a bleaching effect on many delicate fabrics, wallpaper, etc., besides tarnishing metals. Carbon disulphide is also recommended, but its vapour is inflammable. Dry heat is now recognised as an effective agent in killing insects. All fabrics will be freed from pests in a very short time if exposed to a temperature of 130° F. Lower temperatures have been found effective against clothes moth larvæ; the latter when exposed in an incubator at 128°, 120°, and 110° F. died in 6, 11, and 31 minutes respectively. Fabrics dipped in water heated to 140° F. will be found to contain no living eggs or larvæ of clothes moths.

It may also be mentioned that there are a number of worthless remedies against these insects, including powdered sulphur, hellebore, and borax; also lavender flowers, cayenne pepper, reasonable strengths of tobacco powder, and other substances are of no value in keeping away these insects. A. D. Imms.

Science in Agriculture.

The somewhat belated appearance of the annual report of the Rothamsted Experimental Station for the year 1921–22 does not deprive it of the perennial interest which must always attach to the doings of this institution. For historically, Rothamsted can claim to be almost the earliest example of the benefits that result from the application of science to industry. From the economic point of view, the discoveries of Lawes and Gilbert take a very high rank in the history of scientific achievement. The most remarkable feature of the early work of Rothamsted was the success with which field and laboratory work were combined. With the ever-growing complexity of all regions of knowledge, it has become increasingly difficult to maintain this tradition. The refinements (the application of statistical methods may be instanced) which modern field research demands, and the revolution in many of the fundamental conceptions of science, are two factors. On the applied side, another obstacle is the smaller apparent margin for improvement in the practice of modern husbandry. Whereas the discoveries of the early workers were productive of changes in farm practice of the order, in terms of economic results, of 100 per cent., in these days, improvements are only possible to the extent, as it were, of 10 per cent.

A recognition of this fact is implied in the statement contained in the report that "the most important development of recent years has been the reorganisation of the work of the Station so as to bring it into touch with modern conditions of agriculture on one side and of science on the other: it is hoped to reorganise in the near future the farm and field work and to improve the field technique." It unquestionably adds to the difficulties of this reorganisation that it should coincide with a period when the whole economic basis of arable farming is so precarious as it is to-day. It is being openly said that arable farming, and particularly the growing of cereals, cannot be made to pay in present circumstances.

In dealing with the finance of the farm attached to the Station, the report states that "from 1920 onwards, the financial results are deplorable, and they show clearly why many of the arable farmers to-day are in their present position." The report does not specifically indicate the most promising line of investigation calculated to remedy this disastrous state of affairs, but there can be little doubt that the Department of Soil Physics, of which the assistant director, Dr. B. A. Keen, is the head, and to which precedence is given in the report, should be so regarded. Under the heading, "The Cultivation of the Soil," some account is given of investigations which promise to yield results which may indicate to the farmer methods by which the cost of cultivation can be reduced, and "costs of cultivation dominate the future of arable farming." In this connexion it may be significant that the American farmer apparently has been able to grow wheat at a profit with a yield of 16 bushels to the acre, whereas the British farmer with a return of 32 bushels is losing money. It is a reasonable deduction that it pays better to reduce the costs of cultivation than to aim at maximum production. In other words, the British farmer may still be paying court to methods the chief recommendation of which is their superior artistry.

In the section headed "The Feeding of the Plant," it is interesting to learn that "broad beans die prematurely unless they receive a homeopathic dose of boric acid in addition to the so-called 'complete' plant food." It is remarkable that a discovery parallel to that of the rôle of accessory food factors in animal nutrition should have been made in relation to plants.

The volume of purely scientific work done at Rothamsted would appear to be considerably greater than that carried on in relation to so-called applied science. As many as fifty-two scientific papers were published during the year by members of the staff. Of these, two were of Royal Society rank, namely:—"The Mathematical Foundations of Theoretical Statistics" (R. A. Fisher), and "A Quantitative Investigation of the Bacterial and Protozoal Population of the Soil" (D. W. Cutler, L. M. Crump, and H. Sandon).

The financial support which the Station now receives from the State is considerable. For the year under notice grants from the Development Fund totalling 22,030*l*. were received. In 1912 the total was approximately 3000*l*. It must be a source of gratification to the director, Sir John Russell, that so great an expansion should have taken place during his term of office.

The Quantum Equivalent in Photo-electric Conduction.

If light of frequency ν is sent through a cold gas which does not absorb it, sensitised by admixture of a second gas which can absorb the light; and the pressure is such that the mean time between two collisions is of the same order of magnitude as the mean life of the excited state of the gas; all those spectral lines of the non-absorbing gas appear which have a smaller excitation energy than $h\nu$. On the other hand, those which require more energy than this are not seen. Results with mixtures of mercury and thorium vapours, and of mercury and silver vapours, using the light of the 2536·7 Å Hg line, agree, on the whole, closely with the above statement. The method can also be used in fixing the series relations between the lines of an element, since it allows us to determine which spectral lines can be excited by an amount of energy smaller than a given amount. Results have been obtained at Göttingen for lead and bismuth, which will shortly be published.

In a paper in the *Zeitschrift für Physik*, 17-3, August 23, p. 202, Messrs. G. Carlo and J. Franck consider the theory more closely, and describe experiments which agree with their conclusions. The sensitising gas A has, as the longest wave of its absorption series, a line of frequency ν, while the corresponding line of the fluorescing gas has the frequency ν_1. Suppose $h\nu : h\nu_1 :: 1 : \frac{3}{4}$; then if light of frequency ν is used, both ν and ν_1 will appear. The elementary act of transmission of energy from an excited atom of A to an atom of B will take place in such a way that $\frac{1}{4}h\nu$ is converted into energy of translation of the colliding atoms. If the temperature is so low that the kinetic energy of temperature movement is small, compared with $h\nu$, the atom receives, besides its excitation energy, the kinetic energy $\frac{1}{2}m_1v_1^2 = \frac{h\nu}{4} \times \frac{1}{1+m_1/m}$. This abnormal velocity of the excited atom of B produces a Doppler effect; the effective frequency is $\nu_2 = \nu_1(1 + \cos\phi v_1/c)$, and this is not absorbed by the other practically resting atoms of B.

An experiment with sodium vapour, sensitised with pure argon, has verified the theory. Sodium vapour can be made to fluoresce by means of the zinc line, 3303 Å, and the sodium can also be excited directly by the D line. Conditions were so adjusted that the tube appeared equally bright with either of these sources, and the light from the fluorescing sodium, in each case, was passed through an absorption tube, containing sodium at a suitable temperature. The light excited by the D line was completely extinguished, while that obtained with the zinc line was much less weakened.

If, in a second experiment, light of frequency ν_1 passes through the mixture of gases A and B, an emission of ν from A can result only if the temperature of the gas is so high that the energy difference $h\nu/4$, which is lacking for the excitation of A, can be obtained on collision from the kinetic energy of the atoms. Experiments have been made with thallium and mercury, and with cadmium and mercury, using the Hg line 2536·7 Å. The quartz vessel containing the vapours was placed in an electric oven, which could be raised to 800° C.; and strong fluorescence was obtained with thallium. In this case it was possible that a thallium line, the excitation energy of which amounts to 5·5 volts, while the energy of 2536·7 Å corresponds to 4·9 volts only, was due to a double or step-by-step process of excitation. At 800° C. part of the atoms are no longer in the normal state; and apparently there is a 1 volt excitation step, from which, up to the 5·5 volts stage, only 4·5 volts would be required, or more than for 2536·7 Å.

With cadmium and mercury this difficulty does not arise, and the confirmation of the theory is direct. It is possible, however, to draw conclusions from the relative intensity of the lines in the fluorescent spectrum of thallium, as compared with the ordinary spectrum of this substance. The differences are ascribed to the differences in absorption, due to the presence or absence of the Doppler effect previously described; and the combined results of the two experiments seem to prove, conclusively, that quantum energy and translation energy can work together, as an elementary act, to produce excitation of the atom.

Early Methods of Oil Painting.[1]

By Prof. A. P. Laurie.

It is evident both from the manuscript of Theophilus and the manuscript of Eraclius that the properties of such drying oils as linseed oil and walnut oil were thoroughly understood as early as the 12th century, if not earlier.

The methods used in their preparation differ very little from the best practice of to-day. The refining and bleaching of the oil and the use of driers was well understood, nor is there any indication, in passing from those earlier recipes to those of the 15th century, that any new discovery of importance was made at the time of the brothers Van Eyck. Passing to later times, Vasari directs that pigments are to be ground in walnut oil or linseed oil, and this is all that is necessary; he recommends the use of walnut oil as less liable to darken with time.

Many recipes for varnishes are given, and, as neither spirit of turpentine nor alcohol was available in commercial quantities until the end of the 15th century, these varnishes are what we should now describe as oil varnishes, consisting of resins dissolved in hot oil. The natural balsams of the pine, resin, mastic, and sandarac, often all mixed together, were used in the preparation of these varnishes. The proportion of resinous material to oil being very high, the varnishes were consequently very sticky and had to be heated and rubbed on with the hand. Spirit varnishes corresponding to the mastic varnishes of to-day are found in 16th century and later recipes.

The evidence of the accounts preserved at Ely and Westminster show that both oil and varnish were used in painting on walls during the 13th and 14th centuries, this being the northern tradition, while the Italian tradition was the use of egg as a medium. There is no indication in these recipes of any special secret differing from what we know to-day.

These early pictures were painted on a wood panel sometimes covered with strips of linen and coated with a gesso made of parchment size and whitening or plaster of Paris which had been soaked in water until it lost its binding properties. Recent experiments carried out by Mr. Thompson at the Heriot-Watt College, Edinburgh, on an old 16th century panel have revealed the fact that this panel was coated with a non-absorbent gesso upon which a very thin layer of absorbent gesso was laid so as to ensure the binding of the oil to the surface of the gesso and, at the same time, to preserve from staining the pure white surface

[1] Synopsis of lecture delivered at the Royal Academy of Arts, London, on Wednesday, November 14.

of the gesso below. On this pure white gesso panel the picture was drawn in detail and laid out either in monochrome or partly in colour with pigments probably mixed with size. Upon this were laid the pigments ground in oil, or it may be an emulsion of varnish and egg, care being taken to paint the high lights very thinly as compared with the rest of the picture. In course of time the oil yellows and the pigments, more especially the white lead, get more translucent. By painting the picture in this way the artist ensures that the increased translucency of his white lead will correct the yellowing of the oil owing to the white light being reflected from the gesso, and that his contrast of light and shade will be maintained.

There is much more yet to be discovered as to these early methods, and the question as to whether varnish, emulsion, or oil was used, has still to be finally cleared up, but our knowledge of the general methods of procedure is growing.

The Geological Society of China.

THE Geological Society of China is one of the scientific institutions founded since the establishment of the Chinese Republic in 1911. The first two Bulletins of the Society promise well for its future. One of the first papers deals with the history of geology in China, which it carries back to early times; but it shows that independent Chinese work on the subject on scientific lines dates from 1911, when V. K. Ting and H. T. Chang returned to China from their western studies. Mr. Chang, the first president of the Society, organised a department and school of geology under the Ministry of Commerce at Nanking in 1912. The Geological Survey of China was established in 1916 with Mr. Ting as its director, and he also secured in 1918 the reopening of Mr. Chang's geological school, which had been discontinued in 1916. To Messrs. Ting and Chang is due the establishment of the promising school of Chinese geology. They have been aided by Mr. Lee, a Chinese student who was trained at Birmingham, Prof. Grabau, the well-known American palæontologist, now professor at Pekin, and Dr. Gunnar Andersson, formerly head of the Geological Survey of Sweden, and now mining advisor to the Chinese Government and director of the Geological Survey Museum.

The two Bulletins contain a valuable series of contributions to the geology of China. They include a lecture given to the Society by Prof. Berkey, of Columbia University, New York, on "the New Petrography," which attaches most importance to the mode of origin of rocks; Prof. Berkey proposes a plethora of new names such as reactionite, saturite, evaporite, disintegrationite, and recrystallisationite. The new petrology must be vigorous to sustain such a nomenclature. The section of this paper of most interest is its expression of the reaction in America against the ingenious quantitative arrangement of rocks which is often known as "the American classification." Prof. Berkey represents that classification as mechanical and misleading, and sets it aside as only a side issue in real petrology.

Prof. Grabau contributes three papers, of which the longest is on the Sinian system; he protests against the modified use of that term proposed by Prof. Bailey Willis, who, with the temporary agreement of von Richthofen, interpreted Sinian as Lower Palæozoic. Von Richthofen, however, appears soon to have gone back from that modification of his term. Prof. Grabau justly holds that the term is in that sense useless, and he applies it to the sedimentary formations in China of pre-Cambrian age. In that sense it is equivalent to the Toridonian, which, as well as the Sinian, Prof. Grabau includes in the Palæozoic.

Mr. Wong contributes a short note upon Chinese earthquakes and on the distribution of the chief seismic centres. The red beds in China are discussed in three papers. Mr. Wong shows that those in Shansi belong to two horizons, one pre-Jurassic and the other later than the Jurassic Coal Measures. Mr. Hsieh shows that in Kansu these deposits range from the Jurassic to the Kainozoic. Mr. Tan describes a marine red series of Eocene age as widely developed in Shantung, and its discovery is one of the most interesting recent additions to Chinese geology.

Three papers by students of the University of Pekin on observations during an excursion to the Nankou district add materially to the knowledge of that now classical section. Prof. Grabau describes from their collections three new species of Collenia, which he explains are based only on the external characters; in the absence of microscopic evidence it must be quite doubtful whether these supposed calcareous algæ are of organic origin. Prof. G. B. Barbour, of the Pei-yang University, Tientsin, describes an intrusive sill in Shantung which, according to his interpretation, shows the effect of gravitational differentiation. The intrusion is pre-Cretaceous, and the later folding and faulting in this region are now definitely identified as Oligocene or Miocene, as the movements are later than the newly discovered Eocene deposits and earlier than the Pliocene.

The two volumes are in English, with a title-page and contents and a summary of one paper in Chinese. Chinese characters are given of the personal names. The titles of some papers which are to be published in future bulletins suggest that the interest of this serial will be well maintained.

J. W. GREGORY.

University and Educational Intelligence.

ABERDEEN.—The Senatus Academicus has awarded the following research scholarships: Fullerton scholarship in science to Mr. Charles Bisset; Robbie scholarship in chemistry to Miss Margaret F. Aitken.

A mural tablet in memory of the late Prof. James W. H. Trail, F.R.S., professor of botany in the University from 1877 until his death in 1919, has been placed in the classroom of the new Department of Botany, and was unveiled and presented to the University, on behalf of the subscribers, by Sir David Prain, on Friday, December 7. The tablet is mounted on a slab of slate. A portrait plaque in dull green bronze is surrounded by a wreath of oak leaves, acorns, and galls. It is flanked by two Brazilian palms, and a decorative panel shows other natural objects representing the varied interests of Prof. Trail. The tablet is the work of Miss Alice B. Woodward. The subscribers have also issued a memorial volume which, besides biographical and bibliographical matter, includes the "Flora of the City Parish of Aberdeen," a comparative and historical work of great detail which had occupied Prof. Trail for many years, and had been completed shortly before his death.

CAMBRIDGE.—A fellowship has been founded at Christ's College by Mr. J. Pierpont Morgan, a member of the College. This is the first addition to the number of fellowships in the College since 1682, and represents a valuable endowment all too rare in these modern times.

The Empire Cotton Growing Corporation has offered to the University a sum of 1000*l.* a year for five years to be devoted to the Plant Genetics Depart-

ment of the School of Agriculture, in accordance with a scheme that has been agreed upon by the Corporation and the Director of the Plant Breeding Research Institute.

Prof. C. E. Inglis, Prof. B. M. Jones, and Prof. G. I. Taylor have been appointed as members of a committee to make recommendations to the Trustees of the Edward Busk Studentship in Aeronautics.

Mr. E. G. D. Murray, research bacteriologist to the Medical Research Council and formerly on the staff of the War Office Central Cerebro-spinal Fever Laboratory, has been elected to a fellowship at Christ's College.

LIVERPOOL.—Applications are invited for the Campbell Brown chair of industrial chemistry. The person appointed will be required to devote his time to research work, with a certain amount of advanced teaching on the chemistry of oils, fats, and waxes other than mineral. Applications must reach the Registrar of the University before March 1 next.

LONDON.—Applications are invited for the Quain professorship of physics, tenable at University College, in succession to Sir William Bragg. They should reach the Academic Registrar, University of London, South Kensington, S.W.7, by, at latest, January 3. Applications are also invited for the University readership in statistics at the London School of Economics. The latest day for the receipt of applications by the Academic Registrar of the University is January 4.

ST. ANDREWS.—An interesting experiment is to be tried in the institution by the University Court of a series of courses of lectures to be held in University College, Dundee, for the convenience of the managing and clerical staff of the L. and N.E. Railway or of other railways. The first course to be carried out is that in railway law, Mr. James Allison having been appointed lecturer. It is intended later to hold courses in railway economics, railway geography, and railway operating.

THE following have been elected as representatives of the Universities in Parliament :—Cambridge : Sir Geoffrey Butler (U.) and Mr. J. F. P. Rawlinson (U.) ; London : Sir S. Russell-Wells (U.) ; Combined English (Birmingham, Bristol, Durham, Leeds, Liverpool, Manchester, and Sheffield) : Sir Martin Conway (U.) and Mr. H. A. L. Fisher (L.) ; Combined Universities of St. Andrews, Glasgow, Aberdeen, and Edinburgh : Rt. Hon. Sir H. Craik (C.), Sir G. Berry (C.), and Mr. D. M. Cowan (L.) ; Queen's University, Belfast : Col. T. Sinclair (U.).

THE Bradford Technical College may shortly become a constituent college of the University of Leeds. It originated in weaving and designing classes at the Bradford Mechanics' Institute in 1877. The main building, finished in 1882, includes lecture rooms and laboratories of departments of chemistry, dyeing, engineering, architecture and building, biology, mathematics, and physics. A textile block, opened in 1911, includes a practical dye-house, finishing shed, special dyeing research laboratory, and a power house specially arranged for demonstration and experimental purposes. Since 1920 there have been added a new engineering block, specially equipped for advanced work and research on internal combustion engines, and union buildings with refectory and common rooms and athletic grounds.

THE provision of ten post-graduate scholarships for the session 1924–25 for overseas students at the Imperial College of Science and Technology, South Kensington, has been announced. Lord Buckmaster, chairman of the governing body of the College, made the offer to the Secretary of State for the Colonies on behalf of "private friends" inspired by the great purpose and opportunity of the College, the only educational institution in Great Britain on the governing body of which are representatives of the Dominions and India, and it has been accepted. The scholarships will be each of the value of 300*l*., and two will be available for university students of each of the Dominions of Canada, Australia, New Zealand, South Africa, and of India. No conditions have been laid down as to the selection of scholars, this being left entirely in the hands of the Prime Ministers of the Dominions and of the Government of India.

CONTACT between the Secondary School and the community it serves is, according to the report of the West Riding Education Committee for 1922–23, conspicuous by its absence, the prevailing local opinion being that these schools are primarily, if not entirely, intended to produce teachers—this, notwithstanding that in fact less than 20 per cent. of the pupils enter the teaching profession and notwithstanding the efforts made to secure recognition by employers of the "First" and "Second" examinations. In connexion with these efforts some headmasters have, says the report, interviewed local chambers of commerce and have modified their school curricula in the light of information thus gained, in order to bring it into closer relation to local industries. The committee recently permitted its inspector in charge of secondary education to visit the United States for the purpose of studying American schools. In that country much attention has, of late, been devoted to promoting co-operation between the school and the local industries.

THE twelfth annual conference of Educational Associations will be held on January 1-11, at University College, Gower Street, London, W.C.1, under the presidency of Sir Henry Hadow. The presidential address on "The Claims of Scholarship" will be delivered on the first day of the meeting by Sir Henry Hadow. In all, some forty associations concerned directly or indirectly with education will be holding meetings and conferences. Among the papers and lectures to be given are the following, the body responsible and the date being given after the author's name in each case : "The Value of Psycho-Analysis to the Educator," by Miss Barbara Low (Montessori Society, January 1) ; "The Sun and Stars," by Sir Richard Gregory (School Nature Study Union, January 2) ; "Modern Developments in Education and the Outlook for the Future," by Mr. J. Howard Whitehouse and others (Society for Experiment and Research in Education, January 3) ; "School Reform," by Prof. J. J. Findlay (King Alfred School Society, January 4) ; "The Teaching of Hygiene and Racial Progress," by Mrs. Hodson (Eugenics Education Society and Ling Association, January 4) ; "Handwork and Life," by Mr. E. Young (Educational Handwork Association, January 5) ; "Recent Advances in the Relations of Psycho-Analysis to Education," by Dr. J. Glover (British Psychological Society, January 7) ; "Light and Life," by Sir Henry Gauvain (Association of Teachers of Domestic Subjects, January 8) ; "The Question of an International Language," by Prof. F. G. Donnan (International Language (Ido) Society, January 9). An exhibition by publishers of books, maps, etc., has been arranged as in former years, but the exhibits will be placed in the College Memorial Hall where there is more room for an adequate display. Scientific and kindergarten apparatus, etc., will form a separate exhibition.

Societies and Academies.

LONDON.

Royal Society, December 6.—E. G. T. **Liddell** and Sir Charles **Sherrington**: Recruitment type of reflexes. Isometric myograms of the crossed knee-extensor reflex examined in the purely "spinal" preparation present the features interpretable as "recruitment" very much as in the decerebrate preparation. The reflex process answerable for "recruitment" is therefore obtainable in purely spinal centres without the adjuvance of prespinal. An attempt to classify various reflexes on the criterion of presence or absence of "recruitment" is briefly entered on.—G. S. **Carter**: The structure and movements of the latero-frontal cilia of the gills of Mytilus. The structure of these cilia has been investigated by means of the micro-dissection needle. They are complex, and are composed of 10-15 simpler structures which have the form of triangular plates. In the living cilium they are placed in contact one behind the other in the plane of the beat, and together form the blade of the cilium. Their external edges are formed by fibres, which are each attached to a basal granule lying within the cell. These plates will beat independently, and it is concluded that they rather than the compound cilia form the units of ciliary action in these cells. The difference in rigidity shown by the cilium during the two phases of the beat is also shown when a motionless cilium is pushed by the needle in the two directions.—V. B. **Wigglesworth** and C. E. **Woodrow**: The relation between the phosphate in blood and urine. Ingestion by man of doses of the acid and alkaline sodium phosphates containing 1·5-2 gm. of phosphorus causes a rapid 50-60 per cent. increase in the blood phosphate, which then returns very gradually to the normal level. In the dog, phosphate is excreted rapidly by the kidneys instead. The curve of urinary excretion of phosphate runs roughly parallel to that of the blood concentration, but the former varies more widely, and is roughly proportional to the excess above a certain value in the blood. Under conditions in which the blood phosphate is subnormal, normal, or slightly above normal in amount, the concentrations in plasma and corpuscles are identical. When the concentration in the plasma rises far above normal the value for the corpuscles is always lower, whether the plasma value is rising or falling. This unequal partition cannot be explained by the formation of an organic "acid-soluble" phosphorus compound in the corpuscles, for the organic fraction of the acid-soluble phosphorus is not increased by the ingestion of phosphate.—J. B. S. **Haldane**, V. B. **Wigglesworth**, and C. E. **Woodrow**: (1) The effect of reaction changes on human inorganic metabolism. Overbreathing diminishes the phosphates in blood and urine, while carbon dioxide inhalation and sleep increase them. In acidosis caused by ammonium-chloride ingestion the urinary phosphate is increased; while the phosphate of the blood, and also its organic acid-soluble phosphorus, is diminished. Ammonium-chloride acidosis leads to an increased excretion of water, sodium, and potassium, probably owing to a partial loss of electric charge by the body colloids. This is followed by a retention. (2) The effect of reaction changes on human carbohydrate and oxygen metabolism. The alkalosis of over-breathing or bicarbonate ingestion converts the blood sugar into a highly dextrorotatory, unoxidisable form, and also prevents glucose storage; thus causing acetonuria and lowered respiratory quotients and glucose tolerance. Ammonium-chloride acidosis interferes with the storage of glucose, but not with its oxidation. Bicarbonate ingestion raises the resting oxygen consumption; ammonium-chloride ingestion usually lowers it.—J. A. **Campbell**: Concerning the influence of atmospheric conditions upon the pulse-rate and "oxygen-debt" after running. The "oxygen-debt" for 25 minutes after ceasing to run showed, under fixed conditions of experiment, a range of variation of 38 per cent. from day to day; 7-minute debts showed a range of 33 per cent., so should do as well for comparative purposes as 25-minute debts. Atmospheric cooling power had no effect on the "oxygen-debt"; the blood sent in greater volume through the skin in warm conditions is not then taken from the muscles. "Stitch" was the commonest cause of cessation of running in the subjects under observation. Pulse-rate is markedly increased under warm conditions. The oxygen tension surrounding the muscles was increased after exercise.—J. **Gray**: The mechanism of ciliary movement. IV. The relation of ciliary activity to oxygen consumption. In the absence of atmospheric oxygen, ciliary activity continues for about one hour. The whole ciliary mechanism is divisible into three distinct parts: (i.) a reaction which is sensitive to cations (particularly the hydrogen-ion), any interference with which involves a change in the rate of the ciliary beat, but only ultimately leads to a change in the amount of oxygen consumed; (ii.) a mechanism, brought into operation by the presence of an activating acid substance, which is inoperative in the absence of calcium, and in the absence of a certain critical amount of water in the cell. The events associated with this mechanism are independent of the amount of oxygen absorbed; (iii.) a reaction of an oxidative nature which is necessary for prolonged activity. The properties of the ciliary mechanism seem to form a very close parallel to those of cardiac muscle.

Association of Economic Biologists, November 16.—Mr. J. C. F. **Fryer** and J. **Davidson**: The Colorado-beetle problem. Colorado beetle was discovered in the United States in 1829; in Europe, outbreaks occurred in 1877, 1887, and 1914 in Germany, and in 1901 at Tilbury. About a hundred square miles in France, extending into the provinces of Gironde, Landes, Dordogne, and Charente Inférieure, are now infected. The beetle would probably find Britain sufficiently congenial, and would do damage at least equal to the cost of controlling its ravages by artificial means (by spraying potato crops twice yearly). It would arrive in the adult stage, and casual individuals might be expected hidden in merchandise or on board ship, particularly in potatoes from the infested area, or in agricultural produce packed in the area.—J. W. **Munro** and W. E. **Hiley**: The spruce budworm problem in Canada. The term "spruce" budworm is a misnomer for the balsam (*Abies balsamea*), the favourite host plant of the budworm, which is the larva of *Tortrix fumiferana* Clem. A brief description of the forest condition under which the budworm outbreaks occur was given, and emphasis was laid on the system of management of exploiting the eastern Canadian forests in favour of the less valuable balsam. This has caused an unduly high proportion of balsam regeneration in the cut over stands which favours the budworm. An important parasite (*Phytodietus* sp.) of the budworm was absent from these woods. Outbreaks of secondary insects and fungi follow budworm outbreaks. Of the insects, a bark-beetle (*Pityokteines sparsus*), a weevil (*Pissodes dubius*), and a longicorn beetle (*Monochamus scutellator*) are the most important. Fungi, among which the honey-fungus (*Armillaria mellea*) is the most important, spread rapidly during and after budworm outbreaks. After a budworm epidemic the balsam trees that have been

partially defoliated but not killed gradually recover, but a fresh lot of casualties occurs about four or five years after the disappearance of the budworm. These trees, which appeared to have recovered their normal amount of foliage, generally died suddenly during hot weather, and the whole of the crown died at about the same time. Examination of a large number of dead and dying trees failed to disclose any sufficient parasitic cause for the casualties. During and immediately after a budworm attack the breadth of the annual rings is very greatly reduced, and a few years after the epidemic the total thickness of the last five years' rings might be reduced to a quarter of the normal for the pre-budworm period. At the same time the leaf area of the trees has been increasing very rapidly. Thus a time is reached when, during hot, dry weather in July, the water-conducting tissue is insufficient to meet the needs of the transpiring leaves and the crown dies from lack of water. Thus death may be due to a lack of co-ordination between shoot growth and cambial activity.

Zoological Society, November 20.—Dr. A. Smith Woodward, vice-president, in the chair.—W. E. **Le Gros Clark**: Notes on the living tarsier (*Tarsius spectrum*).—Sir Sidney F. **Harmer**: Cervical vertebræ of a gigantic blue whale from Panama.—J. R. **Garrood**: Two skeletons of the cetacean *Pseudorca crassidens* from Thorney Fen, Cambridge.—Dr. Francis, Baron **Nopsca**: Reversible and irreversible evolution; a study based on reptiles.—C. **Crossland**: Polychæta of tropical East Africa, the Red Sea, and Cape Verde Islands; and of the Maldive Archipelago.—Miss Joan B. **Procter**: (1) On new and rare reptiles from South America, (2) On new and rare reptiles and batrachians from the Australian region.

Geological Society, November 21.—Prof. A. C. Seward, president, in the chair.—L. J. **Wills**: The development of the Severn Valley in the neighbourhood of Iron-Bridge and Bridgnorth; with a section on the Upper Worfe Valley, in collaboration with E. E. L. **Dixon**. The area investigated is roughly delimited by the following localities: Much Wenlock, Buildwas, Oakengates, Shifnal, Worfield, Hampton Loade, Morville. Detailed mapping of the drifts has shown, first, that the Buildwas area was as deeply eroded as now in pre-Glacial times; and, secondly, that a belief in the existence of the Iron-Bridge Gorge at that time is incompatible with the distribution of the drifts on the plateau above Iron-Bridge, and with the features of the gorge. The gorge is of late-Glacial origin, and the Worfe Vale was formerly the main drainage-line on the south-east side of the plateau. Practically the whole district was under ice at the maximum of the north-western or Irish-Sea glaciation. When retreat began, the ice-sheet separated into two lobes that remained confluent in the north. The waters of the Glacial lakes formed west and north of the watershed escaped at different times over different cols. One of these overflows is of especial importance in connexion with the origin of the Iron-Bridge Gorge: namely, the Lightmoor overflow, about a mile north of Iron-Bridge. Up to about this stage, the Worfe and its tributaries (one of which now became the Iron-Bridge Gorge) had been engaged in clearing the drift out of their valleys, and in reducing the thalweg of the trunk river to a base-level. Hereafter deposition of the "Main" Terrace of the Severn and of the terrace-like gravels of the Worfe commenced. Long after the initiation of the Iron-Bridge Gorge, ice still covered the upper Worfe Valley. When the ice retired to the north of the watershed hereabouts, Glacial Lake Newport came into being, and subsequently united with the Buildwas Lake on the retreat of the ice-front from the foot of the Wrekin. The outflow at Iron-Bridge thus increased. The subsequent rejuvenation of the Severn below Iron-Bridge was probably brought about chiefly by an elevation of the whole land relative to the sea. Stages in this rejuvenation are marked by terraces.

Royal Microscopical Society, November 21.—Prof. F. J. Cheshire, president, in the chair.—F. I. G. **Rawlins**: The miscroscope in physics. A strong plea is made for the closer union of physics and microscopy, more especially for the undertaking of work in physical optics by the amateur microscopist. Assuming the availability of an instrument fitted with Nicols, a convergent substage system and a Becké lens above the eyepiece, observations can be made of the traces of the family of isochromatic surfaces, each with its characteristic retardation. The work can be made quantitative by employing monochromatic light. If the usual means of obtaining such radiation are not at hand, Wratten filters (especially Naphthol Green) are efficient, though their range of usefulness is limited. The number of fringes observed with objectives of different numerical aperture can be represented by an exponential expression of the form $F = F_0 e^{-AN}$, where F is the equivalent focal length of the objective and N the number of fringes observed (see Rawlins, *Phil. Mag.* xliii. p. 766, and xlvi. p. 992).

EDINBURGH.

Royal Society, November 5.—T. J. **Jehu** and R. M. **Craig**: Geology of the Barra Isles. The rocks are mostly members of the Archæan complex, and these are of igneous origin, the prevalent types being biotite and hornblende gneisses. Muscovite is also present in the more acid types, and locally some of the gneisses are rich in garnets. The foliation planes usually strike N.N.W. and S.S.E., with a dip to the E.N.E. at varying angles. Intrusions into the orthogneisses occur in the form of granulites and pegmatites. The Archæan complex is affected by well-marked zones of shearing, along which mylonisation and the production of flinty crush phenomena can be traced. The macroscopic and microscopic characters and behaviour of the flinty crush material prove that these peculiar rocks are the product of mechanical stresses which at places have raised the temperature to an extent sufficient to bring about partial fusion of the crushed members of the complex, followed in certain cases by incipient crystallisation. The later dykes include olivine dolerites, crinanites, quartz dolerites, and camptonites. Evidences of glaciation are conspicuous, and prove that the ice moved over the islands from S.E. to N.W.—T. H. **Osgood**: Variation in photo-electric activity with wave-length for certain metals in air. As a source of ultra-violet light, a quartz mercury-vapour lamp was used in connexion with a monochromatic illuminator. The metal plates were tested in air at atmospheric pressure, due attention being paid to the "fatigue" which is known to take place under these conditions. The results are of interest and may be of some practical importance in connexion with the physiological effect of ultra-violet light. As the primary cause of the physiological change produced by light is probably photo-electric action, the photo-electric activity of a metal plate may serve as a means of estimating the quality and intensity of the effective radiation.—H. W. **Turnbull**: A geometrical interpretation of the complete system of the double binary (2, 2) form. The double binary form may undergo an algebraic transformation which corresponds to a generalised geometrical inversion. Here the convariants of a (2, 2) form reveal sets of

four or six lines, and special sextic curves with many simple geometrical properties, all connected with a given confocal system of bicircular quartic curves.

MANCHESTER.

Literary and Philosophical Society, November 20.—G. H. **Carpenter**: Warble-flies of cattle. The larvæ of the two common species of Hypoderma (*H. bovis* De Geer and *H. lineatum* Villers) are among the best-known parasites of domestic cattle in the British Isles, in Europe, and in North America; their economic importance is considerable on account of the damage caused to flesh and hides by the large maggots feeding just beneath the skin of the back which they perforate, and also because of the loss of condition suffered by the cattle when they "gad" in summertime to escape from the female fly approaching to lay her eggs. Observations carried on since 1905 by Carpenter and his colleagues in Ireland, by Gläser in Germany, and by Seymour Hadwen in Canada, have shown that the early life history of these insects presents some surprising features. The eggs of both species are generally laid on the legs (from thigh to hoof), rarely on shoulder or flank, never apparently on the back. By examination of the skin after egg-laying and by means of a series of experiments with calves, muzzled so that they could not lick themselves or one another, it has been demonstrated that the mode of entrance into the host's body is not by the mouth. The eggs are hatched on the hairs a few days after laying, and the tiny maggots, less than a millimetre long and provided with strong, sharp mouth-hooks and relatively formidable spiny armature, crawl along the hairs and bore their way directly into the skin. Thence they migrate upwards and forwards to the gullet-wall, the sub-mucous coat of which serves as their resting-place for some weeks or months in the course of their journey through the host's tissues to the final position in the back. The number of larval stages is still to be determined. The gullet-maggot is so much larger (up to half an inch) than the newly-hatched maggot, that it has generally been regarded as representing a second stage, but it possesses mouth-hooks of the same size and form and a spiny armature that is easily overlooked on account of the increase in actual size of the larva, so that the spines are relatively far apart. Hence Gedoelst has recently argued that there is no "moult" between the newly-hatched and the gullet-dwelling larva—only extraordinary growth. On the other hand, Laake concludes not only that the migrating maggot is a second instar succeeding the newly-hatched insect that bores in, but also that there is an antepenultimate instar beneath the skin, differing from the migrating maggot in the total absence of spines on the body-segments.

PARIS.

Academy of Sciences, November 19.—M. Albin Haller in the chair.—G. **Bigourdan**: A project for a French national biography.—M. **Lecornu**: Elastic couplings. A mathematical discussion of the effect of an elastic coupling between a dynamo and its motor on the steadiness of rotation. It is shown to be impossible to decide, in a general manner, whether the elasticity of the coupling is or is not favourable to the regularity of the motion of the dynamo.—Charles **Moureu**, Charles **Dufraisse**, and Philippe **Landrieu**: Remarks on the principle of a general method for determining the heat capacity of solids and liquids and its application to the determination of the water value of calorimetric bombs. The principle of the method suggested by the authors in a previous communication (*Comptes rendus*, 176, 1513) had been anticipated by Pfaundler (1869) and Swietoslawski (1909).—Gabriel **Bertrand**: The transport of copper in the gaseous state and copper-carbonyl. M. Gelinsky has explained a curious example of pseudomorphism by assuming the volatility of copper oxide. This would not appear to be the true explanation of the phenomenon. Copper oxide heated in a stream of either oxygen, hydrogen, or carbon dioxide gives no appreciable transport of the metal even after several hours. But with carbon monoxide there is produced a copper ring, apparently due to the formation of a volatile copper-carbonyl, readily dissociated on heating. The bearing of this observation on the determination of traces of copper in organic substances is indicated: with a brass burner and the material exposed to the gases from the flame, copper may be transferred from the burner to the ash. On the other hand, carbon monoxide formed during the combustion of the organic substance may carry away traces of copper.—Paul **Vuillemin**: New proof of the dystrophic origin of scyphia.—S. **Winogradsky**: The direct method in the microbiological study of the soil. The results of thirty years' work on the microbiology of the soil are, in the author's view, unsatisfactory. The conditions of culture in the bacteriological laboratory are too far removed from the conditions actually existing in the soil, and tend to form new races of organisms distinct from the types in the soil from which they were originally obtained. A scheme of culture is proposed more closely approximating to natural soil conditions.—E. **Baticle**: A mode of compensation for shrinking in concrete arches.—M. **Mesnager**: Remarks on the preceding communication.—E. **Huguenard**, A. **Magnan**, and A. **Planiol**: Research on the surplus of power of birds in flight.—M. **Delanghe**: General method for determining graphically the elements of flight of an aeroplane.—Bernard **Lyot**: Study of the planetary surfaces by polarisation. By the use of a more sensitive polarising apparatus than that hitherto employed, the proportions of polarised light from the planets has been studied. Details of 70 observations on the planet Venus are given.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the second quarter of 1923. Observations were possible on 86 days during the quarter: the results are summarised in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—J. de **Schokalsky**: The length of the rivers of Asiatic Russia, and on the system of measuring rivers on maps in general.—Maurice **Curie**: Spark spectra in non-metals in the liquid state. Studies of spark spectra between platinum points in bromine, liquid oxygen, fused sulphur, liquid nitrogen, and fused phosphorus. In all cases a continuous spectrum was obtained. The absorption bands of oxygen were clearly shown.—E. **Brylinski**: Michelson's experiment and the contraction of Lorentz.—Léon and Eugène **Bloch**: New extension of the spark spectra of tin and zinc in the Schumann region. Tables of wave-lengths of lines and intensities are given for tin from $\lambda = 1699$ to 1305, for zinc from $\lambda = 1556$ to 1310.—R. de **Mallemann**: The electric double refraction of camphor and carvone.—Edmond **Bauer**: The change of wave-length accompanying the diffusion of X-rays.—Jean **Fallou**: A very simple method permitting the determination experimentally of the dispersion reactance of triphase alternators.—Adrien **Karl** and S. **Lombard**: The estimation of radium in the natural titano-niobates. The method is based on the removal of silica with hydrofluoric acid, fusion with potassium bisulphate, addition of sulphates of sodium and lithium to lower

the melting point, re-fusion and removal of the emanation in a current of air.—Victor **Henri**: The structure of molecules and the absorption spectra of substances in the state of vapour.—M. **Chavastelon**: The diffusion of sulphur vapour in air at the ordinary temperature. Particles of solid sulphur emit vapour at ordinary temperatures, and these diffuse only a short distance from the sulphur particle. The vapour was rendered evident by the stain on silver.—D. **Gelinsky**: The metallisation of organisms. In an attempt to determine the nitrogen in whole insects by the Dumas method, in which the insect was covered with copper oxide, combustion was incomplete. The whole surface was found to be covered with metallic copper, the effect being as though copper had been deposited electrolytically.—J. **Froidevoux**: The estimation of ammoniacal nitrogen in certain nitrogenous materials, and particularly in proteids and their products of hydrolysis.—C. **Gaudefroy**: The dispersion of double refraction in crystals.—M. **Charcot** and Louis **Dangeard**: Researches in submarine geology in the Mediterranean. Cruise of the *Pourquoi-Pas*, 1923.—E. **Rothé**: The principle of a method of exact determination of the propagation of seismic waves.—Marcel **Baudouin**: The markings on the prehistoric clay statues from the cave of Montespan, near Saint-Martory (Haute Garonne), are pittings representing Ursa major.—P. **Nobécourt**: The production of antibodies by the tubercles of Ophrydeæ.—Jean **Charpentier**: Application of the biochemical method of characterisation of galactose to the study of the composition of the pectins. The products of hydrolysis of four pectins from different plants were submitted to the biochemical method described in previous communications: in each case the crystallised β-ethylgalactoside was obtained proving the presence of galactose.—J. **Beauverie**: The circumstances which may modify the effect of the "critical period" on the yield of wheat.—E. and G. **Nicolas**: New observations on the influence of hexamethylenetetramine and of formaldehyde on the bean.—H. **Ricôme**: The intervention of gravity in phototropism.—E. **Roubaud**: The physiological condition of zootropism in mosquitoes. The views of J. Legendre (NATURE, November 17, p. 747) as to certain mosquitoes attacking animals in preference to man require modification: captivity, hunger, or deprivation of water may cause an immediate change in the habits of the insect.—H. **Barthélémy**: Physiological and experimental polysperma in the uterine eggs of *Rana fusca*.—J. **Athanasiu**: The supposed existence of a stimulating wave which is propagated in the myocardium.—M. **Nicati**: Orientation and visual sense of duration.—Jacques **Benoit**: The experimental transformation of sex by early ovariotomy in the domestic fowl.—J. **Chevalier** and E. **Dantony**: The toxic action of the insecticide principle of pyrethrum flowers.

Official Publications Received.

Sixty-first Annual Report of the Government Cinchona Plantations and Factory in Bengal for the Year 1922-23. Pp. 6+xii. (Calcutta: Bengal Secretariat Book Depot.) 8 annas.

University of Illinois: Engineering Experiment Station. Bulletin No. 137: The Strength of Concrete; its Relation to the Cement, Aggregates and Water. By Prof. Arthur N. Talbot and Prof. Frank E. Richart. Pp. 118. (Urbana, Ill.: University of Illinois.) 60 cents.

Federated Malay States. Report of the Secretary for Agriculture, Straits Settlements and Federated Malay States, for the Year 1922. Pp. 16. (Kuala Lumpur.)

Bulletin of the Experiment Station of the Hawaiian Sugar Planters' Association. Agricultural Chemical Series, Bulletin No. 47: A Study of the Phosphates in the Island Sugar Lands. By W. T. McGeorge. Pp. 51. (Honolulu, Hawaii.)

The Transactions of the Leeds Geological Association. Jubilee volume, Part 19, 1920-1, 1921-2, 1922-3. Edited by J. H. Everett. Pp. 59+8 plates. (Leeds.) 5s.

Department of the Interior: The Dominion Astrophysical Observatory, Victoria, B.C. A Sketch of the Development of Astronomy in Canada and of the Founding of this Observatory; a Description of the Building and of the Mechanical and Optical Details of the Telescope; an Account of the principal Work of the Institution. By J. S. Plaskett. Pp. 37. (Ottawa: F. A. Acland.)

Bulletin of the American Museum of Natural History. Vol. 48, Art. 11: Classification of the Lizards. By Charles Lewis Camp. Pp. [illegible]-481. Vol. 48, Art. 12: Avian Fossils from the Miocene and Pliocene of Nebraska. By Alexander Wetmore. Pp. 483-507. Vol. 48, Art. 13: Further Notes on the Molars of Hesperopithecus and of Pithecanthropus. By William K. Gregory and Milo Hellman. Pp. 509-530. Vol. 48, Art. 14: The Scales of the Cyprinid Genus Barilius. By T. D. A. Cockerell. Pp. 531-532. Vol. 48, Art. 15: Crocodilian Pelvic Muscles and their Avian and Reptilian Homologues. By Alfred S. Romer. Pp. 533-[illegible]. Vol. 48, Art. 16: Skull Characters of Alligator Sinense Fauvel. By Charles C. Mook. Pp. 553-562. (New York.)

United States Department of Agriculture. Department Circular [illegible]: The Occurrence of Diseases of Adult Bees, II. By E. F. Phillips. Pp. 34. (Washington: Government Printing Office.) 5 cents.

Diary of Societies.

MONDAY, DECEMBER 17.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—W. C. Noxon: Settlement within the Empire.

ROYAL SOCIETY OF MEDICINE (General Meeting), at 5.—Drs. R. Hutchison, Fairbairn, J. Collier, E. I. Spriggs, Crichton Miller, M. Culpin, and J. A. Hadfield: Discussion—Chronic Abdominal Pain in Nervous Women.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—G. R. A. Murray and others: Discussion on Students in Electricity Undertakings.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—F. E. A. Manning: The Management of a Sand and Flint Quarry.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—R. G. Collingwood: Sensation and Thought.

ROYAL INSTITUTE OF BRITISH ARCHITECTS (at 1 Wimpole Street), at 8.—R. Unwin: Higher Building in Relation to Town Planning.

FARADAY SOCIETY (at Chemical Society), at 8.—Discussion on W. H. J. Vernon's Report to the Atmospheric Corrosion Committee of the British Non-Ferrous Metals Research Association.

INSTITUTION OF THE RUBBER INDUSTRY (at Engineers' Club, Coventry Street), at 8.—Col. S. Clarke: The Position of the Rubber Tyre Industry.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Rev. W. Weston: The Influence of Nature on Japanese Character.

TUESDAY, DECEMBER 18.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—H. Faber: Agricultural Production in Denmark, 1909-13 and 1922.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineers), at 5.30.—H. T. Chapman: Arterial Roads and their Effect upon Transport.

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—W. Sellar: A Basis for the Explanation of Marine Gear Troubles.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—B. C. Wickison: Combination Printing.

WEDNESDAY, DECEMBER 19.

ROYAL METEOROLOGICAL SOCIETY, at 5.—W. H. Pick and S. P. Peters: Note on the Vertical Visibility (estimated looking downwards) at Cranwell, Lincolnshire, during the period February 1922 to June 1923.—Dr. H. Jeffreys: The Cause of Cyclones.—A. W. Lee: The Relation of the Circulation in the Upper Air to a Circumpolar Vortex.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. W. J. Sollas: The Method of Investigating Fossils by means of Serial Sections, and some of the Results obtained.—J. Walton: The Structure and Investigation of Fossil Plants.

ROYAL MICROSCOPICAL SOCIETY, at 7.45.—Dr. R. J. Ludford: Melanin Formation and its Relation to the Nucleolus in a Melanotic Cancer.—Dr. J. A. Murray: Reflecting Analyser for the Polarisation Microscope.

THURSDAY, DECEMBER 20.

INSTITUTION OF MINING AND METALLURGY (at Geological Society) at 5.30.

INSTITUTION OF STRUCTURAL ENGINEERS, at 7.30.—J. B. Clarke: Practical Designing of Structural Steelwork: Beam Connexions and Clarke's Loading.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (at Royal Society of Arts), at 8.—Inaugural Meeting of the Kinematography Group.—W. Day: Kinematography and its Antecedents.

CHEMICAL SOCIETY, at 8.—W. E. Downey: The Relation between the Glow of Phosphorus and the Formation of Ozone.—Prof. T. M. Lowry: The Origin of Mutarotation and the Mechanism of Isomeric Change. A reply to Baker, Ingold, and Thorpe.—F. Challenger and F. Pritchard: The Action of Inorganic Haloids on Organo-Metallic Compounds.—J. F. Wilkinson and F. Challenger: Organo-Derivatives of Bismuth. Part VII. Iodo- and Nitro-Derivatives of Triphenylbismuthine.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.15.

FRIDAY, DECEMBER 21.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group Meeting), at 7.—A. H. Blake: Pictorial London.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. U. Williams: Fallacy of the Dropped Colon.—Dr. H. A. Harris: Some Problems in Bone Growth.—Dr. R. W. A. Salmond: The Teaching of Normal Radiography and Radioscopy.

PUBLIC LECTURES.

SATURDAY, DECEMBER 15.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: My Excavations in Malta.

THURSDAY, DECEMBER 20.

KING'S COLLEGE, at 5.30.—Prof. C. K. Webster: The League of Nations and Europe (League of Nations Union Lecture).

NATURE

SATURDAY, DECEMBER 22, 1923.

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Science in Civilisation.

A STIRRING appeal on behalf of "International Thought" is put forward by Mr. John Galsworthy in a pamphlet just published with that title (Cambridge: W. Heffer and Sons, Ltd. Price 6*d.* net); and in it representatives of science, finance, and the Press are urged to combine to save the civilised world from self-destruction. The most potent director of this triumvirate is held to be science, which has placed in the hands of mankind powers with which it is not fit to be entrusted, as the ethical or moral sense has not kept pace with this development of knowledge. "We have made by our science," says Mr. Galsworthy, "a monster that will devour us yet, unless by exchanging international thought we can create a general opinion against the new powers of destruction so strong and so unanimous that no nation will care to face the force which underlies it."

Mr. Galsworthy is not alone in associating science chiefly with agencies of death and destruction, and in pleading for a curb to be placed upon its powers. It is, indeed, common to regard science as a disturbing influence in human affairs, and to sigh for the simple life away from the restless spirit of inquiry into all things visible and invisible in the universe. It is, however, as futile to rail against the progress of science, or to attempt to prevent it, as to use Mrs. Partington's mop to keep back the rising flood of the Atlantic. Knowledge will grow from more to more whatever the attitude of the public may be towards it. During the last fifty years there have been more scientific discoveries and applications than in the whole previous history of the human race; and we may be on the threshold of developments by which forces will be unloosed, and powers acquired, beyond what have hitherto been known to man. Whether these shall be used to promote social well-being and international amity is not a question for science, but for the public and its leaders. While nations look to war as the ultimate means of deciding disputes, they will seek to possess themselves of the most powerful means of imposing their wills upon others. As Prof. Soddy recently remarked, should it be possible ever to release the great store of energy in the atom, the first use that would be made of it would be to construct a new bomb.

It is only by such an international understanding as is suggested by Mr. Galsworthy that this misuse of scientific discovery can be avoided, yet, in spite of the existence of the League of Nations, the signs of the times are not very favourable towards the unity of mankind. Science itself is international, and the results of research are free to all for any purpose. In the hundreds of scientific papers published weekly in the

world, there is scarcely one deliberately concerned with providing any fighting service with more effective means of destruction, and not one scientific worker in a hundred sets himself intentionally to make such a discovery or invention. It is just as impracticable, however, to prevent the wrong use of scientific powers by individuals as it is to prevent literary people from the misuse of their genius for purposes of gain. The facts of science are as free as the words of our language, and in both cases they may be used for the uplifting of mankind or for its degradation.

The truth is, as Mr. Baldwin remarked in his speech at the Guildhall on November 10, the present troubles in the world are largely owing to the fact that while men have learned to control forces of Nature they have not learned to acquire control of themselves. He urged that more pains should be taken to apply the methods of science to human problems, and by that he obviously meant not the development of poison gases and high explosives, but the principle of facing facts honestly and fearlessly, and basing just conclusions upon them. The methods of science should be the methods applied to social problems if sound principles of progress are to be determined. The Labour Party's recent manifesto says nothing of what science has done or may do to improve the world in this way, but asks, "Can the method of science be applied to nothing save the organisation of men for war and their equipment with instruments of destruction?" We have here a paraphrase of Ruskin's assertion that "The advance of science cannot be otherwise recorded than by the invention of instruments to kill and put down noble life"—a view in which distorted vision is combined with the sin of ingratitude.

Modern civilisation is built upon science, and almost all industrial developments had their origin in principles or substances discussed in scientific laboratories by investigators working purely for the advancement of natural knowledge. The principle that a moving magnet can create a current of electricity in a coil of wire near it, discovered by Faraday nearly a century ago, led to the construction of the dynamo, and was the seed from which the great industry of electrical engineering has grown. It is estimated that this industry now represents a capital of more than one thousand million pounds, and it could not have existed without the discovery by Faraday of the fundamental principle of all electro-magnetic machinery. All the pure copper required for this machinery and electrical purposes generally is produced by electrolysis, and here again the principles used were discovered during scientific investigations by Davy and Faraday. Aluminium—that most useful metal, which is destined to compete with iron and steel in its importance—is now manufactured exclusively by electrolysis of a fused mineral containing it.

The electric furnace was first used by the French chemist, Moissan, in scientific research; and now it is employed for the production of hundreds of thousands of tons of steel annually. Calcium carbide, used so extensively in the production of acetylene gas for house lighting and motor lamps, and for oxy-acetylene welding, is entirely manufactured by heating lime and coke together in an electric furnace. The discovery of X-rays was an incidental result of researches into the nature of electricity, and the existence of electric waves, which led to wireless telegraphy and telephony, was first proved in a laboratory. Long before the thermionic valve had made the wonderful achievement of broadcasting possible, the effect upon which it is based was the subject of scientific investigation, and studies of the emission of electrons disclosed the principle upon which it depends.

Nearly a century and a half ago it was shown by Priestley and Cavendish that, when electric sparks are passed through air, some of the nitrogen and oxygen combine to form oxides from which nitric acid or nitrates may be afterwards obtained. This is the principle of the process by which hundreds of thousands of tons of nitrates are now produced annually in Norway for use as agricultural fertilisers in the place of saltpetre from Chile. The process needs, however, a supply of cheap electric power to make it commercially profitable.

When Germany was cut off from natural supplies of nitrates during the War, she had to obtain what she wanted from the nitrogen in the air, and was so successful that more than a million tons were produced in 1918. The method used was based upon the principle of catalysis, whereby chemical combination is promoted by the presence of small quantities of particular elements, which thus act as matrimonial agents. Nitrogen and hydrogen were passed under pressure over finely divided iron, and a certain amount of the two gases combines under these conditions to form ammonia, which, by being passed with oxygen through tubes containing another catalytic agent, may be converted into nitric acid. The hydrogen required for combination with atmospheric nitrogen is obtained by electrolysis of water, or from water-gas and steam by a process depending upon catalysis. The nitrogen is obtained by distilling liquid air. Nitrogen is more volatile than oxygen, so it distils off first and the two gases may thus be separated.

The methods used in the manufacture of liquid air and other gases, and in modern refrigerating machines generally, are based upon scientific experiments by Joule and Kelvin on the phenomena attending the free

expansion of gases. They found that, when air issues from a small orifice, a fall of temperature is experienced amounting to half a degree Fahrenheit for each atmosphere of difference of pressure between the two sides of the orifice. The great refrigerating industry thus had its origin in the discovery of a purely scientific principle.

It is the same with substances as with principles and processes—they are first found as the result of scientific research and are afterwards used, often after a long interval. The metal tungsten used for the filaments of electric bulb lamps and thermionic valves was scarcely known outside scientific laboratories a few years ago. It was discovered about 1785, but its uses were not understood until nearly a century later. It is an essential constituent of high-speed tool-steels, which require to be not only extremely hard but also to maintain their hardness at high temperatures, even at an incipient red-heat. Tungsten steel is also used for the permanent magnets of telephones and the magnetos of every motor car and aeroplane. Manganese was in existence long before it was made an ingredient of the famous Hadfield steels, used for the helmets of British forces during the War, armour-plates, tramway points, and many other purposes. Chromium is used in the making of stainless steel; titanium, molybdenum, nickel, vanadium, and other elements are similarly employed to give special properties to steels, yet all these elements were discovered by scientific investigators without a thought of their practical value. Thorium and cerium, used in the manufacture of incandescent gas mantles, of which about four hundred millions are made annually, were products of the chemical laboratory many years before they gave rise to a large industry; and even the air-burner itself used for such mantles and in all gas fires was first devised and used by Bunsen for laboratory purposes.

Every scientific discovery, however remote it may seem at the moment from the ordinary practical needs of life, may be the seed from which will grow a mighty tree under which man will build his industrial tent. When argon was isolated from the air in 1895, no one regarded the discovery as of any practical importance, yet the gas is now used in half-watt and other gas-filled electric lamps as the most suitable for the purpose. Neon, isolated from the atmosphere a little later, is widely used for the brilliant pink glow lamps of illuminated advertisements, particularly in Paris, where it is a by-product of the manufacture of liquid air. Probably the most remarkable example of this kind is afforded by the gas helium, which was detected in the sun by Lockyer and Janssen in 1868, twenty-six years later was extracted from cleveite by Ramsay, and is now produced to the extent of thousands of cubic feet daily from natural gas wells in the United States for the inflation of dirigibles and other air-ships. As it is non-inflammable and non-explosive, it has decided advantages over hydrogen for this purpose and is only slightly heavier.

Before things can be used in any way they must be discovered, and it is the particular function of science to reveal them. It is the business of the scientific investigator to discover, of the engineer or inventor to recognise and apply the results achieved, of the artisan to employ his skill in making them commercially profitable, and of the community to see that they are used to promote social welfare. If the world has not been made any happier by what science has given to it, the fault is with the human race itself and not with science. Happiness is a relative term, and no two individuals have the same cup with which to measure it. The beast in the field, or the pig in its sty, may be considered by some people as emblems of content, and if these be the standards to use, then modern man may envy the cave-dweller of prehistoric times. We cannot, however, avoid progress, and whether this is accompanied by increased happiness or not depends upon ourselves. We live in a beautiful world, yet how few there are who find delight in it or raise their eyes to the starry heavens above them. The gifts of God are for those to enjoy who will, and the gifts of science may likewise contribute to the uplifting of the human race if they are rightly regarded, or its degradation if they are not. The attitude of civilised man towards new scientific knowledge at this epoch of the world's history is that of a child playing with fire. It is necessary now more than ever to teach him the strength as well as the danger of the element in his hands, and to cultivate the desire to make the noblest use of all things which are granted to him through the achievements of workers for the advancement of natural knowledge. When this spirit prevails, the human race will prove itself worthy of the opportunities which science gives for social and spiritual progress, and man may indeed become but a little lower than the angels.

The Valuation of Mines.

Mineral Valuation. By Prof. Henry Louis. Pp. x+281. (London: C. Griffin and Co., Ltd., 1923.) 15*s*. net.

THE principles underlying the valuation of mines, whether for the purpose of sale or probate, the raising of loans, investment, or taxation, are not so fully comprehended, except by few mining engineers, or so widely known as they should be. Consequently, in the matter of actual valuations, judging from those which have come before us, these principles are

frequently incorrectly applied. In the case of valuations for assessment of Poor Rate the abjuration of principle is, perhaps, most manifest.

Books on the subject of the valuation of mines and minerals are not numerous, and some, like Hoskold's "Engineers' Valuing Assistant," are either out of print or, in some measure, incorrect. We welcome, therefore, the appearance of Prof. Louis's admirable contribution to the subject.

The work covers, in seven chapters, a fairly wide field, treating, as it does, of the principles of valuation, ownership of mineral leases and concessions, sampling, explanation of the formulæ in use, examples in the valuation of coal and metalliferous mines, and valuation for special purposes, *e.g.* rating, etc. Chapter ii., relating to "Mineral Deposits," is perhaps the best in the book, the occurrence of minerals being a subject of which Prof. Louis has had wide experience and on which he has written much. Under this head he describes simply and with lucidity the manner of occurrence of minerals in beds, veins, and masses, indicating the variations in point of value to which they are subject.

His dissertation on the "probability of error" in the determination of the thickness of deposits for computation of the contents (chapter iii.) is of much interest; but the method usually adopted by mining engineers and alluded to by Prof. Louis on p. 50 is, perhaps, as satisfactory as any other method, namely, "after calculating average values as closely as the available data permit . . . to deduct a certain percentage 'for safety.'" The author is insistent, and rightly so, on the impossibility of assigning "to any mineral property an absolutely definite value, but only a most probable value." Whilst this is particularly true of a mineral property, by reason of the variations in regularity of deposits, of selling prices, and the general risks attendant on mining, it is of course true also, to a lesser extent, of other things as well, *e.g.* agricultural land, owing to the risks to crops due to bad seasons, variation in selling prices, etc. To meet the greater uncertainty of mines, valuers allow in the computation of the value of the annuities an unusually high rate of "remunerative" interest.

The debateable subject of subsidence of the surface due to extraction of minerals (as to which a Royal Commission, of which Prof. Louis is a member, is at present inquiring) is touched upon, and the author rightly says (p. 69), "It will be seen that we are still very far from having arrived at anything like an accurate estimate of the requirements in any given case, and it will always be well to be guided by local experience obtainable from previous workings whenever such is available." But the author might, with advantage, have mentioned Fayol's theory of the dome which reconciles so many of the seemingly contradictory results of different observers regarding subsidence, this theory being to the effect that in stratified deposits the zone of subsidence is limited by a sort of dome, which has for its base the area of the excavation; the extent of the movement diminishing the further one goes away from the centre of that area.

The question of depreciation of plant enters into mine valuations; it may, indeed, be an important item: an immense sum is often expended on the plant, for example, of a deep modern colliery. In making the allowance for depreciation, Prof. Louis criticises what he terms the income tax method; "it is charged each year upon the value of the plant less the amount of depreciation written off the previous year." He says, seeing that the plant can never come down to zero, and that, under the method he criticises, the amount written off for depreciation is a maximum when the machinery is new and becomes very small as the machinery gets older, the method is wrong. The value of the plant at the termination of the lease—if the property is leased—of course depends, amongst other things, on whether the minerals in the leasehold are exhausted or not, and on the site of the mine; and, on the second point, at a well-managed mine renewals of machinery and plant are carried out to a considerable extent during a long-termed lease, which to some extent militates against Prof. Louis's criticism, though not entirely.

Chapter v. treats of "Formulas and Calculations." Why, by the way, does Prof. Louis prefer this plural to the one in common use—"formulæ," and, whilst on the subject of grammar, why does he prefer "under these circumstances" to "in these circumstances"? The formulæ are mainly those familiar to students of Hoskold's "Engineers' Valuing Assistant" and King's "Theory of Finance," the latter being the best work, known to the present reviewer, on the doctrine of interest and annuities certain. The exigencies of space forbid a detailed review of this section of the book, but it may be noted that the author directs attention to the necessity of making the proper and necessary deduction for income tax in the calculation for the recovery of capital. Likewise, "if the capital be invested in the purchase of mineral rights . . . it becomes further liable to mineral rights duty in accordance with the Finance (1909–1910) Act," namely, 1*s.* in the pound. It is not generally realised what a difference there is between the gross and net income derivable from the ownership of mineral lands; mineral rights duty being chargeable *after* the deduction of income tax.

On the vexed question of the proper formula to apply for the determination of the present value of a deferred annuity in which two rates of interest are involved, Prof. Louis recommends (p. 101) that which was, we believe, first put forward by Mr. George King, and is accepted by the Inland Revenue in valuations for the purposes of probate. The simplest form in which this can be stated is that given by the reviewer in a work of which he is joint-author, namely, where:

Y.P. = years' purchase.

a = the amount to which 1*l.* per annum accumulates in e years at r per cent.

A = the amount to which 1*l.* per annum accumulates in t years at r per cent.

r = the accumulative low rate of interest.

R = the remunerative high rate of interest.

d = the period of deference.

e = the period of enjoyment.

t = the total period $= d + e$.

Then
$$\text{Y.P.} = \frac{a}{1 + \frac{\text{AR}}{100}}.$$

Allusion has been made at the commencement of this review to want of adherence to fundamental principles in valuation of mines for purpose of assessment of rates, the basis of which is, by law, the annual value. There are no less than sixteen different methods of assessment in use in England and Wales, but there can be no doubt that the fairest is that advocated by Sir E. Boyle, namely, to value the surface works and plant as the non-directly productive works of a railway are valued, and the mine on the gross receipts upon coal raised, excluding colliery consumption, and deducting therefrom the expenses incurred in getting and raising the coal, *i.e.* to take as the value the net income derivable from the coal.

All who seek enlightenment on this and other branches of the subject of valuation of minerals cannot do better than study Prof. Louis's admirable and comprehensive work. Richard Redmayne.

Dutch Potters and their Work.

Old Dutch Pottery and Tiles. By Elisabeth Neurdenburg. Translated with Annotations by Bernard Rackham. Pp. xv+155+59 plates. (London: Benn Bros. Ltd., 1923.) 84*s.* net.

It is a pleasure to welcome this competent, scholarly, and interesting account of that renowned pottery-work of the Dutch craftsmen and artists which exercised such a profound and quickening influence on the potter's art as it was practised in all the countries of northern and central Europe, especially during the course of the eighteenth century. We already possess, in English, quite a number of small handbooks which treat of this important subject; but here, at last, a volume is presented which may be acclaimed as worthy and complete in its text, and is also so handsomely illustrated as to satisfy every requirement of the collector.

One praiseworthy feature, which immediately arrests attention, is the frank simplicity with which the many troublesome questions concerning the date or even the period of the various types of pottery and tile-work manufactured in the different towns and provinces of Holland are discussed and their origins elucidated. The factories at Delft, most famous of Dutch pottery-towns, are described at length, and we have interesting personal accounts of their proprietors and the principal painters in their employ; though we are still, fortunately, in the time when the proprietor of a pottery was his own principal artist or master-craftsman. The factories at Rotterdam, Haarlem, The Hague, and those in the province of Friesland are not overlooked, though, as is only to be expected, they do not receive the same detailed notice, for their pottery was not of the same importance either in quantity or in technical excellence.

The descriptive account of the native peasant-pottery and tiles, enriched with decorations in "slip" or with more ambitious designs in "sgraffiato," strikes one as somewhat meagre and unilluminating. This is a matter for regret, when we remember the extensive and splendidly decorative use which was made of these simple methods by our English potters of the seventeenth and eighteenth centuries.

Of the famous tin-enamelled wares, with their brilliant and effective painted decoration in blue or in polychrome, the book gives an excellent and convincing account. We are shown, by a documented narrative, how the processes were first introduced into Holland and how the mingled stream of Italian and Spanish influence fertilised the native art of the Dutch potters; either as a result of the incursions of Italian and Spanish pot-painters or from the return of Dutch potters who had travelled abroad for the increase of knowledge. Thus, an account is given of one, Hendrik Vroom, who travelled to the south of Europe to become qualified as a painter in oils but repeatedly earned his living while pursuing his studies by serving as a painter of pottery; working in Seville for an Italian potter and, later on, at a majolica factory in Venice. By such interchanges the art and craftsmanship were both improved, for the Dutchman sharpened himself on the more fiery metal of the South; so that, when he turned in earnest to the reproduction of Oriental designs, borrowed from the fashionable porcelain of the Far East, he was so well equipped that he was able to take full advantage of the lessons taught by the greatest of

all decorative artists. How fully the lesson was learnt has been demonstrated again and again, as when, on close examination, among a set of Chinese vases used for the adornment of a mantel-shelf one will be found to be a Delft-ware copy of a broken original.

The most famous of the Dutch potters and pottery-painters, such as De Keizer, Pijnacker and Frijtom of the seventeenth century and Van Eenhoorn and Fictoor, who were at work early in the eighteenth century, as well as the later painters like Hoppesteyn and Adrien Pijnacker, are fully dealt with and the characteristic details of handling or treatment by which their work may be distinguished are clearly explained. Valuable and interesting as the work is, it is more than a little disconcerting to find the author indulging in such an unwarrantable statement as is contained in the last paragraph, where she states that when the Staffordshire earthenware of Wedgwood and his compeers displaced the tin-enamelled wares by their fine and eminently serviceable qualities, "The wares which had been the pride of Holland, possessing in their soft, pleasant enamel and cheerful, harmonious colouring a charm unequalled even by Chinese porcelain, went under before the output of an industry to which Dutch craftsmen had given its start." One is inclined to rub one's eyes and wonder if the words flow from some ultra-patriotic writer who, not content with the assured position always accorded to the wares of her native country, must needs exalt them above their proper place by challenging the finest pottery known among men. William Burton.

A Lover of Mountains.

Below the Snow Line. By Douglas W. Freshfield. Pp. viii + 270. (London: Constable and Co., Ltd., 1923.) 18*s.* net

Mr. Freshfield has been, as he tells us, "as much a traveller as a climber," and he offers these "selections from old records of travel" in the hope that they may "convey to a few kindred spirits suggestions of alternative playgrounds near and far off, accessible at times when the High Alps are practically closed." But neither the title of the book nor the innuendo of these sentences must be taken literally. They do no justice to the scope of Mr. Freshfield's journeys, to the amount of true exploration involved, or the depth of the author's knowledge of mountains and mountain ranges, or his great love for mountain travel. After all, they "half reveal and half conceal the soul within." Perhaps the title was a mere chance repercussion from that of Mr. Clinton Dent's "Above the Snow Line." It serves at least to prove that to the true mountaineer all things fall to be considered in relation to the snow line. The lower slopes have no absolute value, save as they lead to the higher, or, if they have the misfortune to be so situated geographically as to have no higher slopes, they are to be considered as opening a prospect of the great hills, or, if even this be denied, as illustrating them in reminiscence.

There is indeed more in it than that. Mr. Freshfield is in grain a traveller; and, though we can scarcely conceive of him as travelling without a mountain as a goal or as a background, his interest in mountains does not consist solely in getting up and down them. He has, it is true, been engaged in doing so for a period that includes almost the whole of the history of modern mountaineering. Mr. Alfred Wills ascended the Wetterhorn in 1854. Mr. Freshfield published "Thonon to Trent" in 1865. A great many things have happened since then. Trent has changed both its nationality and its name, and a whole system of Alpine theory and technique has been evolved. But during all that time Mr. Freshfield has continued to find pleasure on one side of the snow line or another, and to delight those who take the same pleasure by telling them, on occasions all too rare, what he found there and why he liked it. How many summits must his foot have trodden? How many mountain valleys must he have known?

> "Conturbabimus illa, ne sciamus,
> Aut ne quis malus invidere possit,
> Cum tantum sciat esse. . . ."

Mr. Freshfield brings to his task of communicating his pleasure to others qualities more valuable than mere experience. He has an ironic wit, wide reading, and a retentive memory, and he has always written as a scholar and a man of taste. The hardships and discomforts of mountaineering are easier to bear when encountered with a certain rough jocularity. But that which cheers on the hillside is often intensely depressing in the study, and the stock Alpine joke, preserved like a fly in amber in the pages of the Alpine periodicals, has a shrunken and almost repulsive appearance. Mr. Freshfield does not disdain to jest. But he is too witty to be facetious.

Mr. Freshfield will always be associated, in particular, with those Italian Alps which he made his own in the years before 1875 and to which he allured his countrymen by the volume published in that year. That charming book must have sent so many people to the district of which it treats that it is difficult to think of Mr. Freshfield without Val Maggia, or of Val Maggia without Mr. Freshfield. This book cannot hope to make so wide an appeal. It does not happen to every lover of the mountains to have the time to visit Japan or the Mountains of the Moon or the Kabyle Highlands. Not all of us, even if we had time, have the capacity for enduring heat which enables

Mr. Freshfield to take a midsummer holiday in Corsica. Still, here is a fine feast for all who like to commune in spirit with a fellow-lover of the hills. The papers entitled "Behind the Bernina" (Val Malinco, Val Masino, and Val Codera) and "The Bergamasque Alps" are a sequel to "The Italian Alps," and in revisiting these enchanted glens the author recaptures and reproduces the charm of "that large utterance of the earlier gods." The Maritimes and the Gran Sasso are exactly the setting for him, and wherever Mr. Freshfield goes he takes with him the classic writers who have fed his imagination and formed his style. It gives a certain pleasure to catch him out in a misquotation, and that from Milton, a common misquotation from whom dogs Mr. Freshfield's name. It will be found on page 46.

Expositions of Atomic Physics.

(1) *Recent Developments in Atomic Theory.* By Prof. Leo Graetz. Translated by Dr. Guy Barr. Pp. xi+174. (London: Methuen and Co., Ltd., 1923.) 9*s.* net.

(2) *The New Physics: Lectures for Laymen and Others.* By Prof. Arthur Haas. Authorised Translation by Dr. Robert W. Lawson. Pp. xi+165. (London: Methuen and Co., Ltd., 1923.) 6*s.* net.

(3) *The A B C of Atoms.* By Bertrand Russell. Pp. 175. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1923.) 4*s.* 6*d.* net.

(4) *Modern Electrical Theory.* By Dr. Norman Robert Campbell. Supplementary Chapters. Chapter 17: The Structure of the Atom. (Cambridge Physical Series.) Pp. x+161. (Cambridge: At the University Press, 1923.) 10*s.* net.

THE theory of atomic structure has, during the past few years, reached a stage of sufficient success and stability for it to be possible to describe many of its features in a simple manner. There is a general agreement as to the validity of certain fundamental conceptions, such as the nuclear structure, the interpretation of isotopes, and the general functions of the outer electrons, while, to turn to more delicate points, the quantum theory and the wave theory of radiation, like an ill-assorted couple of individually worthy people, have learnt to live together in peace by a tacit agreement not to insist too much on each other's faults, so that it is possible for their friends to ignore their essential incompatibility. In short, the times seem propitious for popular summaries of recent advances in molecular physics, and a large number of such books, appealing to various circles of readers, have recently appeared, some of which are now before us.

(1) England is traditionally successful in the writing of simple scientific expositions for general reading, so that it is the more astonishing that two of these books should be translations from the German, and that these two should be but representatives of a large number of such translations not of works, like Sommerfeld's celebrated treatise, distinguished by great learning and great industry, but of ordinary lectures and essays peculiar for neither novelty of matter nor elegance of exposition. It is difficult, for example, to find any compelling reason for the appearance of Prof. Graetz's book in English dress. This summary of recent atomic theory was written while the War was still in progress (in fact, part of it is based on lectures delivered in territory occupied by the Germans), and, while it has been revised by the insertion of new matter, imperfectly incorporated with the old, the last revision was nearly two years ago. In consequence, the book is seriously behind the times. To take one example only: it is stated, in what purports to be an exposition of Bohr's views, that the electrons are arranged in concentric rings, each ring containing a number of electrons, the model for neutral helium, in particular, being figured with two electrons at opposite ends of the diameter.

Apart from being out-of-date, the book is vitiated by a deplorable looseness of expression which is very liable to mislead the general reader for whom it is intended. We are told that radium emanation loses its activity, "unlike radium, thorium, etc., which keep their activity for ever"; that for reflection to take place, X-rays must fall on the crystal at practically grazing incidence; that the nuclear charge determines the ordinal number in the periodic system, "and therefore determines also its atomic weight." The account of positive rays is bad. In short, the author does not seem to be sufficiently familiar with his material. Altogether, the book is superfluous, and it is a pity that such praiseworthy production in the matter of paper and print as it enjoys should not be devoted to a better object.

(2) The book of Prof. Haas's is a better performance, but is scarcely what it is implied to be, a book for laymen. In a hundred and fifty small pages, the author runs quickly through the electromagnetic theory, the kinetic theory of gases, the electron theory, the quantum theory, recent work on the structure of the atom, and the theory of relativity. It is scarcely necessary, in the face of this programme, to labour the fact that the treatment is far too laconic to be of use to any one with but little foreknowledge of the subjects handled. The language is simple enough, but such features of modern physics as the conception of a black body, the gyromagnetic effect, the quantum of action, and so on, cannot be clearly explained in single paragraphs by the mere device of omitting mathematical symbols.

The book gives a good summary of those branches of knowledge which it handles, a summary which can be read with profit by young students who want to get a general view of what they are learning: it is more like an index than an exposition. Many will differ from the translator, who has otherwise performed his task well, over his decision to express the extreme numbers, usually written in index notation, in words, such as a "quadrillionth part of 1½ grams," or "800 billion per second." It is true that he gives a table of this notation in his introduction, but the scheme is of doubtful advantage.

(3) Now Mr. Bertrand Russell has succeeded in writing a book on the atom which is really accessible to the general reader. He uses a simple and lively style, which does not disdain to find in the flea "which crawls for a while and then hops" an image of the motion of the electron in the Bohr atom. His book is very readable, and gives what is in the main a very good account of the fundamental features of modern atomic theory. Unfortunately, Mr. Russell's unfamiliarity with the practical side of physics has led him into some extraordinary statements, such as that a spectrum which is "a continuous band of colours, like a rainbow," is called a band spectrum, or that fluorescence is "the subsequent emission of light of exactly the same frequency as that which has been absorbed," or that, "broadly speaking, there are three lines, the K, L, and M lines, which make up the X-ray spectra." The author makes an attempt, which seems a little too ambitious, to expound Hamiltonian mechanics without symbols. He has, obviously, written mainly under the influence of Sommerfeld's book: to have rendered some of the main lines of thought in that book comprehensible to a wide circle of readers is no mean feat.

(4) Dr. Norman Campbell appeals to a different circle, that of students who are specialists in physics. He continues the task of bringing parts of his "Modern Electrical Theory" up-to-date by means of monographs which he calls chapters. The book before us shows some of the valuable qualities which physicists have learnt to associate with its prolific author, whose impulsive claim and vivacious enthusiasm in the cause of progress find frequent expression in such a passage as:

"If we are hidebound by tradition, let us by all means stick to Amperean and Maxwellian theory, reject as a pernicious heresy, unsanctioned by the Fathers of the Church, all modern theory of spectra; let us retire as hermits to the desert of ignorance and refuse to have any dealings with the wicked, bustling world of modern science. If, on the other hand, we believe that progress in science is not impossible, and that the age of discovery did not end abruptly in 1870, let us be confident in our beliefs, and attribute to genius in our own time an authority no less and no greater than that of our intellectual forbears."

It is regrettable that this spontaneity of utterance seems to be allied to a breathless haste which has led to the omission of all mention of important pieces of work, and a certain carelessness which impairs much that has been written. It is, no doubt, outside the design of the book to devote attention to the methods of experiment by which the knowledge has been won, but, even so, it seems questionable to say of the positive rays that they "are never homogeneous in velocity," and so to ignore all Dempster's work. It is scarcely fair to Aston to say that he merely "re-designed Thomson's apparatus." It is strange to refer in detail to the discrepancy between the Bohr and the Weiss magneton, and to say nothing of Pauli's theory or of the work of Gerlach and Stern. Nobody is more impressed with the advisability of correctness in dimensions than Dr. Campbell, and yet he gives h, a unit of action, in ergs on page ix, while according to his equations on page 82 and elsewhere it is erg cm.! The notation is at variance with that of chapter xv., and is not consistent in the book itself. The index is futile.

Unfortunately these faults are but typical: it would be a distasteful task, but an easy one, to extend the list. Maturer reflection would, it seems certain, have led Dr. Campbell not only to introduce certain modifications in his exposition, but also to cancel his abuse of Sir William Ramsay, which serves no good purpose. The conclusion is irresistible that the author could have written a very much better book if he had only been willing to take more trouble and more time over it.

E. N. da C. Andrade.

Our Bookshelf.

Electrical Engineering Practice: a Practical Treatise for Electrical, Civil, and Mechanical Engineers, with many Tables and Illustrations. By J. W. Meares and R. E. Neale. Fourth edition, rewritten and enlarged. In 2 vols. Vol. 1. Pp. x + 584. (London: Chapman and Hall, Ltd., 1923.) 25s. net.

In the new edition of Meare's and Neale's "Electrical Engineering Practice," the scope of the work has been widened and the matter has been suitably rearranged. The book is thoroughly up-to-date and reflects clearly the present state of the industrial knowledge of electrical engineering in Great Britain. The authors are a little hampered at times by having to keep closely to the specifications and nomenclature definitions of the British Engineering Standards Association (the B.E.S.A.), the Wiring Rules of the Institution of Electrical Engineers, and the recommendations of the International Electrical Commission. The B.E.S.A. has always many committees sitting revising specifications for materials, machines and apparatus and dealing also with nomenclature and symbols. As these specifications are issued periodically it is not easy for authors to keep pace with them. The committees are not necessarily bound by their previous decisions. For example, the older generation of electricians recom-

mended that "continuous current" and "virtual value" should be used instead of "direct current" and "effective value." The younger generation has simply reversed these decisions. Our sympathies are with the authors who strive to model their nomenclature on the very latest recommendations, and find later that changes have been made. The constant strivings of electrical engineers after standardisation in specifications have done much to stabilise the industry.

The authors in many places where there is doubt give the variants, as, for example, effective virtual and root mean square (R.M.S.), ground and earth, and several other synonyms. They measure both magnetic induction B and magnetic force H in the same unit, namely, the gauss, which is defined to be one line of magnetic flux per square centimetre.

From the teacher's point of view, however, this leads to hopeless difficulties. We can recommend this book to those engineers who have a sound knowledge of theory and want to know the latest practical problems which the engineer has to solve.

Geologic Structures. By Bailey Willis. Pp. xi+295. (New York and London: McGraw-Hill Book Co. Inc., 1923.) 17*s.* 6*d.*

THIS book is essentially different from James Geikie's "Structural and Field Geology," which makes its appeal through its fine presentation of rocks as they actually appear on bare surfaces of the crust. The two works may well stand side by side. Prof. Bailey Willis concerns himself here with the mechanics of rock-displacement and rock-folding, and illustrates these by photographs of his series of models made to illustrate the structure of the Appalachians. He uses mixtures of wax, plaster, and turpentine, producing strata that yield very variously to mechanical stress. The deformation of an incompetent series under load provides material that returns, as it were, into the core of a rising arch formed by competent strata that can lift a load when laterally compressed, or into the core of a syncline when the competent series lies below them and is bent downwards, displacing matter in the depths (p. 148). Hence we have highly crumpled series between strata of more simple curvature. The shearing of materials in sediments as well as in schists, so that new parting-planes are set up, accompanied by thinning and elongation of the mass, is frequently brought before us in this stimulating volume. Moreover, we never lose sight of the tridimensional character of the structures described. There is a valuable chapter on field-methods, in which the author remarks (p. 28) that "the explorer should have the pluck of an American and the self-respect of a Chinese." The book provides geologists with very pleasant reading.

G. A. J. C.

Differential Equations. By Prof. H. B. Phillips. Pp. vi+78. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 6*s.* 6*d.* net.

DR. PHILLIPS's little book is not a treatise on differential equations in the ordinary sense. He does not deal with any but the most elementary equations, and his aim is purely utilitarian, namely, to provide "thorough drill in the solution of problems in which the student sets up and integrates his own differential equation." There are a very large number of problems, with some worked out in the text. The problems are from all branches of applied mathematics, physics, physical chemistry, etc. We can certainly advise students of these subjects to become acquainted with the easier types of differential equations through the agency of Dr. Phillips's attractive and readable book.

A few criticisms of detail may perhaps be allowed. In the example on p. 6 the minus sign should be used *at once* in the form $dR/dt=-kR$, instead of leaving the negative in the form of an incidental result of the calculation. On p. 25 something should be said about the geometrical properties of homogeneous equations of the first order. The definition of phase angle on p. 66 is incorrect. There are also a number of mistakes and misprints.

S. B.

An Introduction to the Study of the Compounds of Carbon, or Organic Chemistry. By Ira Remsen. Revised and enlarged with the collaboration of the author by Prof. W. R. Orndorff. (Macmillan's Manuals for Students.) Pp. xii+567. (London: Macmillan and Co., Ltd., 1923.) 10*s.* net.

REMSEN's text-book has for many years been regarded as perhaps the best introduction to organic chemistry. It is extremely well written and not obscured by tedious details, and is well within the student's capacity. Theory is kept within bounds, and one feels that to the author, at any rate, organic substances are not chalk marks on blackboards. In the new edition the essential character of the book is preserved, but by omitting illustrations and directions for experiments, it has been found possible to bring the text thoroughly up-to-date and to include some rather more advanced material. Very little calling for criticism can be found, but it is suggested that the theory of esterification on p. 67 is unsound, and that ethylene is not most conveniently prepared from the dibromide (p. 276): Newth's method is not even mentioned. Again, on p. 282, some account should have been taken of Chattaway's work. Apart from such trifles, the book is clear, up-to-date, and accurate, as well as readable.

Tracks of British Birds. Edited by H. Mortimer Batten. Life size. Printed on cloth chart, 20 in. by 30 in. (Edinburgh and London: W. and A. K. Johnston, Ltd., 1923.) 4*s.* net.

THIS forms a companion chart to "Tracks of British Animals," already noticed in these columns, and follows the same general lines. Four categories of birds are represented, namely, swamp birds, ground birds, perching birds, and birds of the seashore, each with about ten examples. The tracks are reproduced life-size, and a few brief explanatory notes on the general subject are given at the foot of the chart. Organisations such as Boy Scouts and Girl Guides, in which instruction in the craft of the country side occupies a good deal of attention, will find this chart invaluable, and it will be welcomed by teachers of Nature Study in schools as a most useful aid to the teaching and cultivation of powers of observation. The use of the word mavis as the common name of the song-thrush is, we believe, only general north of the Tweed, and we suggest the addition of the latter name for the benefit of those who are not familiar with the Scotch term.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Hydrone and Water: Thunderstorms and Globe Lightning.

PROF. ARMSTRONG (NATURE, Dec. 8, p. 827) humorously appeals to me and other physicists to rush in and immerse ourselves in his aqueous difficulties, where apparently he hesitates to tread. Had FitzGerald been alive he might have been a willing victim, for he was always ready to apprehend the difficulties of others and often illuminated them by a flash of genius.

Prof. Armstrong sometimes seems more at home in an atmosphere likely to generate heat, than in the placid evolution of electricity or light; but in this instance he really does seem to want a question answered, though he does not put it very clearly. If he wishes us to enter a complex molecular assemblage, like hydrone, we may soon get out of our depth; for we know that he despises H_2O, and even H_2O is not as clearly apprehensible as we should like, in terms of atomic structure. A molecule as big as a fist would in some respects be advantageous. But what has that to do with electrical manifestations?

If we reply to Prof. Armstrong's apparent question in terms of elementary electricity, we shall be told—no doubt with perfect truth—that chemists knew all that before. Still, I will run the risk of a few platitudes. Dr. G. C. Simpson and I have both answered, publicly or privately, about the effect of aggregating small charged spheres into large ones, or vice versa; so to this I will only add that I am more disposed than is Dr. Simpson to attribute a great deal of atmospheric electricity to the influence of an outside source, namely, the sun. But Prof. Armstrong says that his point is more fundamental than that. He harps upon the need for electrodes, and constantly uses the term "circuit." I suggest that he rather over-emphasises these things. Electrodes are only necessary if the separated charges are to be conveyed to a distance by conduction: but they can travel by convection, and electrical separation can occur by displacement. Electrodes are needed for a galvanometer, not for a gold-leaf electroscope.

Examples.—A crystal of tourmaline warmed or cooled will exhibit opposite electrifications at its two ends, and if the crystal could be broken they would be separated. Pressure applied to other crystals shows a similar effect. Any conductor properly broken in an electric field will separate the electricities, just as silk rubbed on glass will exhibit electric separation when pulled apart. The same sort of thing Dr. Simpson expects in broken water drops. And certainly Armstrongs (both of the name) well know that drops of pure water propelled through a suitable nozzle will emerge electrified. In none of these cases are there electrodes, or any obvious circuit, and yet electric energy is displayed.

In a sense, it is true, there must always be a circuit of some kind. Electricity behaves rather like an incompressible fluid of which space is completely full. We cannot generate electricity; we can only separate or decompose and move apart the opposite kinds. But the circuit may be completed by insulated displacement, as well as by conduction.

The position is a little complicated by the singular and surprising fact that positive electricity is more closely identifiable with matter than the negative variety,—a prevision of which fact was intuitively grasped by Benjamin Franklin long ago. This great difference in massiveness between the two kinds of electricity enables electrical separation to go on *in vacuo*, and seems to me likely to be responsible for much of the energy of electrical separation subsequently displayed in the earth's atmosphere,—displayed most obviously when the magnetically separated entities come together again.

But what has all this to do with hydrone and water? Prof. Armstrong will not fail to notice, and probably contemn, my caution in keeping high and dry.

But now to be incautious. If Prof. Armstrong has qualms about supposing that rearrangements or combinations of H_2O in a hydrone molecule can effect electrical separation, I think those qualms are judicious; it would be too much like seeking a generation of one kind of electricity only. At the same time, if any cause can be assigned which would separate the opposite electricities of matter into different regions of a globe, an enormous amount of energy would be displayed, sufficient for ball-lightning. The quantities dealt with are prodigious. But where is such cause to be found? Could the opposite charges be centrifugalised apart? Could they, in rushing together, form a cyclone which would keep them from collapsing together for a time? The speed required, to maintain a shell of protons round a nuclear group of electrons, like a sort of inverted large-scale atom, is not unreasonable. A spherical vortex has been worked out by Prof. W. M. Hicks; what does he think of the suggestion?

I have no wish to enter the lists against the high meteorological authority of Dr. Simpson, but I do not feel that the last word has been said about the electrical energy of thunderstorms. Nor do I suppose that the last word has been said about what constitutes a chemical molecule, nor yet about hydrone.

OLIVER LODGE.

Salisbury, December 9.

Industrial Research Associations.

I HAVE read with much interest the article entitled "Industrial Science" appearing in NATURE of December 1, and I would beg to thank you for pointing out that the scheme of the Department of Scientific and Industrial Research for the establishment of Research Associations has not had a fair chance. Few could have foreseen the difficulties which it has encountered, and still fewer could realise what these actually are unless engaged in industrial operations.

As a firm believer in the ultimate success of the co-operation of science with industry, and as one who has followed closely the initial stages of one of the largest of the Research Associations, I should like to add that I am convinced that the scheme inaugurated by the Department is fundamentally a good one, and in my opinion is likely to have a very far-reaching effect, in helping our industries to face with confidence the unusual difficulties of the present situation, due no doubt in large measure to the lack of appreciation in the past of the value of science to industry.

I am aware that there are many who do not believe in the value of Research Associations, and that recently it was suggested in another journal that the "least direct way of helping industry by science is the quickest: stimulate research at existing institutions," etc. I appreciate most thoroughly the research work that is being done in the universities and similar institutions, and I am in reality most

anxious to secure the help and co-operation of these institutions, but the above suggestion, in my opinion, omits several important considerations. For example, commercial men are not very often in a position to appreciate when the difficulties of an industrial process are suitable problems for scientific research, and as a consequence many problems which should be referred to the universities for scientific help might fail to be so treated. Again, considerable knowledge both of textile processes and of the appropriate sciences is often necessary even to diagnose the cause of a defect, the solution generally requiring the co-operative efforts of the textile expert, the chemist, the physicist, and the botanist. Such qualities could scarcely be found combined in either the university professor or the industrialist.

Even assuming that these difficulties have been surmounted and the university professor is trying to solve an industrial problem, it seems that the writer of the above quotation has scarcely realised the amount of time which the university professor would have to spend in learning the conditions in which his new discoveries would have to be applied, without which information his researches, though they might be very fruitful in the accomplishment of scientific fact, would in all probability be of no real value to the industry. If, on the other hand, the university professor devoted the necessary time and thought to the solution of the industrial problems submitted to him, he might find himself with little or no time to devote to his professorial duties.

For such reasons, and from nearly four years' experience, I am satisfied that efficient co-operation between science and industry can be obtained by means of Research Associations, where highly trained scientific men will have daily intercourse with the industry, either as a whole or with the particular section of it connected with the special research problems they have in hand. In these circumstances such men may not only overcome difficulties as they arise, but, what is far more important, they will also certainly point out new lines of advance. I believe indeed that Research Associations will establish a necessary link between the universities and industry, and will be the means of stimulating the industries to take advantage of the opportunities provided.

Kenneth Lee,
Chairman.

The British Cotton Industry
Research Association,
Manchester, December 4.

Experiments on Alytes and Ciona.

Those who have followed this discussion may be interested in its subsequent course. I lately received the following letter, undated, from Dr. H. Przibram, director of the Versuchsanstalt, to which I have made the reply subjoined. W. Bateson.

December 2.

Vienna, XIII./7,
Hietzinger Hauptstr. 122.

My dear Professor Bateson,

Having read your offer about Kammerer's Alytes in Nature, No. 2811, my proposal is this: that you may carry out your previous intention of coming to Vienna yourself. I would gladly renew my invitation to you to spend some time at my house. Thus you would be given ample opportunity to examine the specimen without risk of its loss. It was mainly my wish to satisfy you that made me consent to Kammerer taking the specimen to England. I am sorry you have not availed yourself of this opportunity, but I could scarcely take the responsibility of entrusting the unique sample to anybody else (I had in fact declined to do so on a previous occasion, as Mr. Boulenger will affirm).

It is not probable that I shall be away from Vienna at any time before the middle of April next. At any rate, please write beforehand, when you intend coming. It would indeed be a great pleasure to see you with us.

In case you have noticed Mr. Munro Fox's letter in Nature, No. 2818, on Ciona, I would like to direct your attention to the fact that the discovery of its siphons lengthening with repeated removal was not made first by Kammerer. It was known so long ago as 1897 by Mingazzini's experiments, which were, in their turn, based on a previous observation of our friend in common, Jacques Loeb, as he mentioned to me in 1907 during my stay in California. So I do not see how Mr. Fox's inability to reproduce the experiment allows him to deny Kammerer's success with the first generation.

Believe me, dear Professor Bateson, most sincerely, your old friend, Hans Przibram.

If you think it desirable that my answer may be known in public, I would be glad if you would send this letter as it is to the editor of Nature for publication.

December 2, 1923.

Dear Dr. Przibram,

I was not without misgiving that difficulties might be raised. For that reason I offered a sum, 25*l.*, calculated to cover the railway fare, 10*l.*, of a special messenger, with a sufficient margin. I understand the obstacle is not financial, or I would gladly now double my offer.

Thank you for a most kind invitation. It would be delightful to see you all in Vienna once more, which I was prevented from doing last year. Some day I certainly hope to come, if only to look at the new marvels of the Versuchsanstalt. But as regards Dr. Kammerer's Alytes, which as it still seems to me ought to be the most convincing exhibit of all, I doubt the value of such a journey. If I were to come, and—as it might happen—return with scepticism unabated, could I do more than add one to the number of those who already have seen and yet have not believed?

In my last letter I explained how I missed making a proper examination here. Reports had varied, and I drew the inference that the nature of the black marks must be mainly a question of interpretation. Not until I saw the toad at the Linnean meeting, with the unexpected and misplaced development on the *palm of the hand*, did I discover that there was anything so positive to examine. As I thought over the incident it struck me as extraordinary that this, the real peculiarity of the specimen—which, indeed, it was set up to display—had never been mentioned by Dr. Kammerer. He left England immediately after the meeting. I might, no doubt, have been a little quicker, but in amends, and in the hope of bringing the matter to a definite issue, I made the offer, not an unfair one, which you have declined.—Yours truly,

W. Bateson.

Colour Vision and Colour Vision Theories.

In a recent letter to Nature (September 29, p. 473) Dr. Edridge-Green has condemned the colour theory of Young and Helmholtz by the sweeping statement: "There is no fact that directly supports the trichromatic theory." It is scarcely credible that such men of science as Young, Helmholtz, Maxwell, and Abney could have deliberately adopted a theory of colour vision with nothing at all to commend it.

Dr. Edridge-Green further states that I have written several papers supporting the trichromatic theory, but implies that they are included among many which though "written to support the trichromatic theory are found on examination to give facts strongly adverse to it." It is true that my papers support the theory, but the inference that they were written for that purpose is incorrect. The papers are discussions of experimental researches on the effects of fatigue of the eye, and the results, usually given in the form of persistency curves, are set forth independent of any theory. The experimental fact, disclosed by the curves, that the disturbances induced by fatigue in the eye invariably affected the red, green, and violet colours, could not in my judgment be interpreted in any other way than in support of the trichromatic theory.

Dr. Edridge-Green also quoted one sentence from one of my papers in which I refer to a difficulty arising from the visual complexity of the part of the spectrum between the wave lengths $0{\cdot}470\,\mu$ and $0{\cdot}570\,\mu$, which includes the region where the sensation curves of Abney and of König have two intersections, and those of Exner three. He states that this part of the spectrum is complex only on the trichromatic theory, while on his it is quite simple, and that my results therefore "should be as stated," or, in other words, accord with his theory. My former experiments, and more especially those very recently published, which show how colour vision in one eye is affected by reflex action arising from fatigue in the same eye and in the other, prove that the spectrum in its physiological action is exactly as complex as the sensation curves indicate it to be. I find a transition point, or, as it now seems better to term it, an equilibrium point or colour, corresponding to each of the intersections of the sensation curves. These facts are experimental, and certainly support the trichromatic theory in the most detailed and explicit manner. Indeed it was the occurrence of these complex intersections of the trichromatic sensation curves that enabled me to predict and later to discover these equilibrium colours.

The difficulty that Dr. Edridge-Green quotes from my paper regarding vision in the green has now been removed by further investigations which are described in a paper, "On Reflex Visual Sensations," recently published in the Journal of the Optical Society of America, August 1923. The solution is remarkably concordant with Prof. Peddie's conclusion contained in his recent book, which had not been published when that paper was written, and also in his letter in NATURE of October 27, p. 621, that in the visual process we have a double set of three variables, one of which arises from the internal action of the visual apparatus. This conclusion to which Prof. Peddie has come, from the interpretation of many phenomena of colour vision, accords with my own experiments on reflex sensations, though I would express it as a set of three variables acted upon by two separate and opposite stimulations, direct and reflex, the former acting to fatigue or depress the sensations, and the latter to enhance them. The double stimulation of the three sensations seems to be the necessary fundamental connecting principle in colour vision. By its employment many facts which were admittedly difficult to reconcile with the trichromatic theory are now seen to be completely in harmony with it.

By the discovery of reflex visual action upon the colour sensations it now seems possible legitimately and confidently to establish the trichromatic theory of colour vision upon the broad physiological foundations so securely laid by the researches of Sir Charles Sherrington.

FRANK ALLEN.

Department of Physics,
University of Manitoba,
Winnipeg, Canada.

PROF. PEDDIE seems to suggest that no one understands the trichromatic theory but himself. I resent his remarks in this connexion, and for this reason, unless some one else joins in the discussion, this is my final letter.

The trichromatic theory, which is very simple, has been thoroughly understood by physiologists since it was propounded. In former times most physicists, like Prof. Peddie, overlooked the physiological aspects of the question, but this is not the case with the physicists of the present day, as may be seen by the writings of Sir Oliver Lodge, Prof. A. W. Porter, Dr. Houstoun, Prof. Andrade, Dr. Troland, Dr. C. L. Martin, and others. The question is primarily one of physiology and not a mathematical problem on the functions of three variables. By physiology we are limited to one set of fundamentals for normal vision for one person. A man cannot have five and six toes on one foot at the same time. Now each set of facts requires a different set of fundamentals which makes the theory quite untenable. Let us compare, for example, the fundamentals of Abney and Burch. Abney gives the red sensation as affected by light of all wave-lengths. Burch gives the red sensation as affected by light from $\lambda 760\,\mu\mu$ to $\lambda 555\,\mu\mu$, with other points of difference. Abney gives $\lambda 548\,\mu\mu$ as stimulating the fundamentals, in sensation luminosities in the following proportions: red sensation, $49{\cdot}7$, green sensation $35{\cdot}6$, and blue sensation $0{\cdot}035$. Dr. Troland writing on the same subject, using the word minuthesis instead of fatigue, gives his results as follows:

"The general conclusion to be drawn from the work is therefore that minuthesis due to one colour does not alter the luminosity of another colour to a degree differing appreciably from that in which it is altered itself. In other words, the change in sensitivity to brightness occasioned by stimulation of the retina is independent of the wave-length constitutions of the minuthetic and of the reacting lights. This seems to imply that the luminosity function is not essentially linked with the color or chromatic function and stands in contradiction to the views of Abney, Ives, and others who treat luminosity as the sum of the primary colour values of any stimulus. The present results appear also to conflict with experimental data along similar lines published by Abney and by Burch, so that further study of the problem would seem to be required on a larger number of subjects."

These results are in a complete agreement with those of Prof. A. W. Porter and myself. (See Proceedings Royal Society, 1912, and the "Physiology of Vision," page 248.) Prof. Peddie's explanations are not explanations on the trichromatic theory: in the first he introduces a fact which can only be explained on my theory; in the second and third he gives no explanation. The positive after-image of red disappears before that for green, therefore on the trichromatic theory, if yellow be compounded of red and green, red having disappeared, the positive after-image of yellow should change to green, which it does not.

F. W. EDRIDGE-GREEN.

London, December 8.

The Optical Spectrum of Hafnium.

IN a letter to NATURE of October 27, p. 618, in which we gave a complete list of the lines belonging to the hafnium spectrum between 2500 and 3500 Å.U., we announced a detailed examination of the remaining part of the spectrum which can be obtained photographically. The result of this examination will be found in a paper, now in the press, which will appear shortly in the Math. Phys. Proceedings of the Royal Danish Academy. This paper contains

a list of all the hafnium lines (about 800) found between 7300 and 2300 Å.U., together with a detailed discussion of our methods and results. In the meantime we give here a list of the strongest lines in the region between 7300 and 3500 Å.U. Some of these lines (denoted in the table with an asterisk) have already been published at the Gothenburg meeting of Scandinavian Naturalists, where, on July 13, we presented a list of some 20 characteristic hafnium lines between 4500 and 3500 Å.U.

The spectra were produced as described in earlier letters to NATURE. In the table the lines are given to 0·01 Å.U. in international Å.U. in air, but the errors may amount to about 0·05 Å.U. In the region of the longest wave-lengths, where the accuracy is less, we give the values to 0·1 Å.U. The intensity is given both for arc and spark spectra in the usual scale (1 to 6). For the longest wave-lengths our spark spectra were not strong enough to permit us to give spark intensities, and above 5100 Å.U. the spark intensities are only of relative value and can be compared directly neither with the corresponding arc intensities nor with the spark intensities of the shorter waves.

λ	I.		λ	I.		λ	I.	
	Arc.	Spark.		Arc.	Spark.		Arc.	Spark.
3505·20	6	6	* 4174·32	4	5	5040·79	6	6
* 3522·98	5	5	4206·54	4	5	5047·43	5	4
* 3535·50	5	5	4232·36	4	6	5181·92	6	3
* 3552·66	5	6	4272·82	4	5	5243·97	5	2
3561·64	6	6	4320·65	4	5	5298·04	6	3
3569·03	5	6	4336·69	5	6	5311·54	6	4
3597·42	4	5	4350·52	4	6	5354·74	6	2
* 3616·86	5	6	* 4356·32	5	6	5373·88	6	3
* 3644·29	6	6	4367·91	4	5	5452·88	5	3
3665·28	4	5	4417·34	4	6	5463·31	6	3
* 3675·73	5	5	4422·70	4	5	5550·58	6	4
* 3682·22	6	6	4533·15	5	5	5552·10	6	4
3699·69	5	5	4565·93	5	5	5613·28	5	3
3701·12	5	6	4598·86	6	6	5719·20	6	4
* 3717·80	5	5	4620·85	6	5	5902·91	6	3
3719 28	6	6	4622·70	4	5	6185·15	5	
* 3777·73	5	5	4655·18	6	5	6386·36	5	
3793·34	5	5	4664·13	5	5	6644·7	6	
* 3899·92	4	5	4782·77	4	5	6754·6	5	
* 3918·06	6	6	4800·51	6	6	6789·4	6	
3923·90	5	5	4837·24	5	5	6819·0	6	
* 3951·80	5	5	4859·24	4	5	7063·7	5	
4062·85	4	5	4863·29	4	5	7131·8	6	
4080·44	5	5	4877·59	4	5	7237·1	5	
4093·16	6	6	4975·20	6	5	7240·8	5	
4127·75	4	5	5018·14	6	4			

As mentioned in our first letter (NATURE, March 10, 1923), we must expect to find some of the most prominent hafnium lines among the zirconium lines measured before hafnium was discovered, as all commercial zirconium contains from one-half to five per cent. of hafnium. In fact, we find in the region of the spectrum, for which Exner and Haschek's zirconium measurements are sufficiently exhaustive, nearly all the strong hafnium lines here given among Exner and Haschek's zirconium spark lines as weak lines of intensity 1 or 2. Since Bachem (Diss. Bonn, 1910) gives only the three lines 6386, 4093, and 3505, these lines may, until further investigations are made, be taken as the most persistent or ultimate hafnium lines in this part of the spectrum.

H. M. HANSEN.
S. WERNER.
Universitetets Institut for teoretisk Fysik,
Copenhagen, November 19.

Scientific Names of Greek Derivation.

MAY I follow Prof. Grenville Cole (NATURE, November 17, p. 724) in supporting Sir Clifford Allbutt? The prefix "dino-," as thus spelled, is ambiguous. We who know that "dinosaur" means "terrible lizard" may smile at the undergraduate and his "dinnosaur." But how would you pronounce "Dinocystis"? Wrongly, no doubt, as I did myself until I learned that the first begetter of the name derived it from δίνειν, to swirl, because the rays are spirally coiled. The same for Dinocharis and Dinophysa. Well, then, what about the giant cork-screw shell from the Hastings Sand—the Dinocochlea of B. B. Woodward? That perhaps means "spiral coil"; or does it mean "monster coil"? Should it, in short, be Deinocochlea or Dinocochlea?

We may, in systematic nomenclature, feel bound by the rules for transliteration recommended by one or other international committee; but in writing English let us be free. Alas! here comes the Society for Pure English with its Tract XIII., and invites us to print "coeval," "medieval," "primeval," and "peony." Why? If you eliminate the bouquet of the grape, the wine may be the purer, but it tastes no better. Already you may hear others than undergraduates speak of ĕconomics and ĕcological. These changes of spelling do not follow the debased pronunciation, they induce it; and so the meaning and force of words vanishes with their savour. Pure English indeed! Fortunately some impure English, called slang, still has "a tongue with a tang."

Next Prof. Cole deals with the writing and printing of diphthongs. The British Museum, he reminds us, writes "Moeritherium." That is because the officers of its Geological Department and others long since discovered that the use of digraphs (œ, æ, etc.) to represent diphthongs was the most fruitful source of misprints. Let us help the printers and our pockets! Otherwise I foresee the day when the undergraduate will call "this fascinating creature" the Merrytherium.

F. A. BATHER.

LIKE Prof. Cole (NATURE, November 17, p. 724) I prefer to transliterate the Greek letters, especially the vowels and diphthongs, directly into English—to represent, for example, αι by *ai* instead of *æ*, and ει by *ei* instead of *i*. Perhaps the worst examples I know of the emasculation of Greek diphthongs are the old-established Miocene and Pliocene, which show not only a weakening of ει to *i*, but also a further degradation of αι to a simple *e*. I am afraid it is too late to restore these words; but I am sorry to say that there are those who, on the specious plea of consistency, wish to write Cenozoic for Kainozoic and to extend this system of transliteration indefinitely. What this means is illustrated by the fate of the two words καινός and κενός, both represented by "ceno-," which in Cenozoic and Cenocrinus means "recent," and in Cenoceras and Cenosphæra means "empty," a most unnecessary and unreasonable confusion of distinct words.

JOHN W. EVANS.

An Uncommon Type of Cloud.

THE type of cloud photographed by Dr. Lockyer (NATURE, November 17, p. 725) is very frequently seen at Kodaikanal in south India during the thunderstorm season in April and May. It is always associated with thunder and always appears after the thunder clouds have expended their electrical energy. This often happens quite suddenly when the storm is of local origin.

On one occasion when developing a photographic plate at the Observatory I received a slight shock from a lightning discharge nearby, or more probably from an induced charge in the lead lining of the developing table. Since then I have hesitated to go up to the Observatory during thunderstorms, and have been accustomed to look out for the "all clear" signal which these mammato-cumulus clouds give us.

Another remarkable fact connected with local thunderstorms at Kodaikanal, and probably elsewhere, is the curious roaring sound emanating from the cloud before a storm begins. At first I considered this was due to heavy rain approaching, but concluded that this could not be so. The situation at Kodaikanal is such that one may find oneself very near to a cloud mass rising over the steep sides of the mountains, and the sound always appears to come from the cloud itself, and not from the ground or from trees. Possibly Dr. Simpson can explain this; he would probably have heard it at Simla.

J. EVERSHED.

Ewhurst, Surrey,
November 25.

Consumption of Fish by Porpoises.

IN the course of our cruises, we have often harpooned porpoises of various species, and occasionally investigated the contents of the stomach. Sometimes the stomach was found to be empty, but in most cases it contained remains of fish, though these were, as a rule, so decomposed by the digestive fluids that identification was impossible. Now and again, however, it could be done. In the vicinity of the Continental Slope, for example, west of the English Channel, where porpoises are nearly always found in abundance, we found great bundles of the pelagic pipe-fish, *Entelurus æquoreus* L., in the stomachs of porpoises taken. But as a rule, the porpoise evidently prefers fish of somewhat more fleshy build than the pipe-fish.

The present note is occasioned by the recent preliminary investigation of a sample from one of the cruises of the *Thor*. On June 24, 1910, being then off the south coast of Spain, in the Mediterranean (between 36° 10′ N., 4° 42′ W., and 36° 19′ N., 4° 0·6′ W.), we harpooned a female specimen of the common long-nosed porpoise (*Delphinus delphis* L.). The stomach contents consisted of fish-residue: more or less dissolved soft parts, crumbling backbones, otoliths, and eye-lenses. I noted that most of the fish-bones were green, but no identification was attempted. The most interesting feature was the great number of otoliths, or ear-bones, of fish. When these were sorted out and counted, there were no fewer than 15,191 of different sizes, though mostly small. Several species were represented, about five; but, owing to lack of material for comparison, I cannot give any further determination at present. Some are presumably those of Scomberesox, clupeoids and scomberoids, possibly also scopelids.

The sample is interesting, inasmuch as it gives some slight idea of the porpoise's enormous consumption of fish: in the stomach of this one specimen we found remains of no fewer than 7596 fish. How long the porpoise took to collect the whole 7596 it is impossible to say, since we do not know how long the otoliths remain in the stomach before being dissolved or passed out. The fact that otoliths are not always found in the stomachs of porpoises seems rather to suggest that they do not remain there very long.

JOHS. SCHMIDT.

Crystallisation of Cementite in Steel.

WITH reference to the particularly interesting article by H. C. H. C. in NATURE of November 17, p. 728, might I mention the following amongst many other examples which have come under my notice illustrating the tendency of cementite to form cell walls or a network under conditions where the occurrence of pearlite is more commonly anticipated? In dead mild steels the occurrence of cementite in either network or comparatively massive formation has been recognised by a number of investigators. Fig. 1 illustrates an exceptional case in which isolated cell walls were found only near the edge of a dead mild-steel plate, in a region otherwise microscopically carbonless. The only apparent explanation of this occurrence was that the plate must have become carburised locally during the processes of manufacture.

FIG. 1.—Cementite network in mild steel. × 300.

FIG. 2.—Cementite in ferrite grain junctions, in nickel steel. × 1500.

In the alloy steels, the simultaneous occurrence of structurally free ferrite and juxtaposed carbide network would be regarded as uncommon, but Fig. 2 shows an instance of this occurrence in a large oil-hardened nickel-steel forging. At the magnification of 2500 with which the original photograph was taken by means of the super-microscope, the carbon-containing constituent can readily be seen to be lamellar pearlite, which makes easy the identification of the carbide plates in the ferrite boundaries.

F. ROGERS.

64A Westbar, Sheffield.

Minute "Organisms" isolated from the Virus of Mosaic Disease of Tomato.

The nature of the infective principle in plants suffering from mosaic disease is obscure, although most recent workers favour the view that it is a living organism. Allard and Duggar have emphasised the minuteness of the causal agent, whilst Matz, Kunkel, Nelson, and others have described protozoan-like bodies in the cells of affected plants.

A considerable amount of work has been done on this problem at Cheshunt, and the present note records the isolation and growth in pure culture of a minute "organism" from the filtered virus of tomato mosaic.

Isolations were made from affected plants by a modification of Noguchi's method. Tubes of sterile extract of tomato stem and leaf (100 gm. fresh material to 1000 cc. distilled water) were prepared, and into each was dropped a small piece of living tomato tissue cut, under aseptic conditions, from the interior of healthy green fruits. Ten tubes were inoculated by touching the tomato tissue under the liquid with a loopful of tomato virus filtered aseptically through a sterile Doulton candle. Ten uninoculated tubes were left as controls. All tubes were incubated in a Bulloch's anaerobic jar for two months, and on removal were found to be clear. The tubes were then left under ordinary atmospheric conditions, and two months later one tube was contaminated by a fungal growth, but the liquid in the remaining nineteen was quite clear in both the inoculated and the control tubes. This liquid was examined for micro-organisms by plating and streaking upon different culture media, but no growth was observed. On the glass, however, of each of the original inoculated tubes about one centimetre above the liquid were small brown bodies, the largest of which was 200μ in diameter. No such bodies were present in the controls.

These bodies were tightly fixed to the glass, and not easily detached. They are brittle and break into fragments of a crystalline appearance. The bodies are discoid convex, and when stained with borax carmine the surface shows concentric and radiating markings. They clear in acid with evolution of gas, the cleared bodies having a fine granular appearance. When stained by Giemsa's method they resemble bacterial colonies, containing deeply stained purple granules standing out distinctly on a stained background. These granules are 0·3 to 0·4μ in diameter (occasionally smaller granules are seen) and appear as cocci, diplococci, polar bodies, or unstained rods. These are not merely crystals or detritus but definitely organised bodies growing in colony formation. Distinctive preparations have been made by staining with Giemsa for 24 hours and then differentiating with absolute alcohol. The granules are best seen in smears made from the cleared colonies prior to fixation by drying.

Tubes of virus kept in the laboratory for six to eighteen months under aerobic conditions revealed similar colonies on the glass in those tubes where no toluene had been added for preservative purposes or from which the toluene had disappeared. After acid clearing and staining, the minute granules were readily demonstrated. Films made from the clear liquid in the tubes bearing the colonies were also stained with Giemsa, and purple-stained granules similar to those so abundant in the colonies were regularly found in these preparations. They were not numerous, five or six only being seen in a single field, and appearing as cocci or as diplococci.

Continued cultivation of the "organism" has been maintained in tubes of tomato extract containing cubes of sterile raw tissue. (The addition of 0·3 gm. calcium carbonate to 10 c.c. of extract hastens the production of colonies. Increased concentration of carbon dioxide in the atmosphere also seems to assist in the formation of colonies and alters their appearance; the brown colonies becoming white and chalky.) Numerous media have been inoculated with negative results, but one inoculation is especially interesting. A flask of lemco gelatine containing a high proportion of gelatine was inoculated with a drop from one of the original culture tubes. No growth was apparent for four months, but after six months the surface was covered with minute hard white bodies, which on examination proved to be similar to those described. Colonies transferred to Noguchi tubes dissolved in the liquid, and films prepared from this ten days later showed the presence of minute granules either singly as diplococci or as aggregates in alveolar plasmodium-like structures in which cocci stood out deeply stained in comparison with the faintly stained matrix.

The bodies forming on the glass of Noguchi tubes and in the liquid, and the lemco colonies, have been inoculated into healthy plants under various conditions; and while there are indications that they may be causally related to mosaic disease, no definite claim can yet be made. The presence of these "organisms" in the virus of tomato plants suffering from mosaic, and their very interesting nature, appear, however, of sufficient importance to warrant the immediate direction of the attention of workers on this difficult problem to their existence. A detailed investigation of the character and genetic relationships of the "organisms" recorded in this note and their relation to mosaic disease is being carried out at Cheshunt. W. F. Bewley.

Experimental and Research Station,
Cheshunt, Herts, December 3.

Globular Lightning.

Your correspondent, Mr. E. Kilburn Scott, suggests in Nature of November 24, p. 760, that "the ball may be a mass of concentrated nitrogen oxides," and considers that this would "fit in well with the formation and action of such gases," and he compares the chemical activity of lightning with the well-known reactions occurring in high-tension arc flames.

Although I do not wish to be understood as expressing any opinion regarding "globular" lightning, I should like to point out that in the letter which appeared in Nature of September 15, p. 396, I produced evidence in connexion with the extremely vivid and prolonged thunderstorm of July 10, 1923, which left no doubt that the chemical changes that occurred then resembled those of the silent electric discharge, rather than high-tension arc flames, because, although there was no increase in the proportion of the oxides of nitrogen in the air within the area of the storm, there was a very great increase in the proportion of ozone.

I may add that since the proportion of nitrogen peroxide is always much higher in London than in country air, and is considerably greater in winter than in summer, we may look, as in the case of sulphur dioxide, to combustion of coal as the probable source of most of it at least. The seasonal changes of the curves for these two variable ingredients of the atmosphere are very similar, and are not in any way related to that for ozone. William C. Reynolds.

"Wharfedale," Upminster, Essex,
November 26.

Rejuvenescence and the Testicular Graft.

By Dr. F. H. A. MARSHALL, F.R.S.

IT has been known from very early times that castration in both man and animals, besides causing the suppression of the sexual instinct, produces marked changes in the bodily conformation and the secondary characters of sex, and that these effects are far more definite if the operation be performed before puberty. There are numerous references to the subject in the works of Aristotle, who remarks on the immense modifications in the general configuration brought about by the mutilation of a comparatively minute organ. The abnormal height of the eunuch, his undeveloped larynx and soprano voice, and the absence of hair on the face and other parts of the body where it is usually present in men are among the well-known effects of testicular deprivation. The domestic animals also furnish striking examples of the consequences of castration, and the same may be said about birds. Thus the testes, besides being responsible for the development of the sexual instinct, are an essential factor in the formation of the bodily characters associated with maleness. The manner in which this influence is exerted, however, has only comparatively recently been ascertained, and there are still many gaps in our knowledge.

According to Berman, the author of "The Glands regulating Human Personality," the first to conceive the idea that the gonads exert their effect through an internal secretion poured into the blood was Bordeu, who was Court Physician to Louis XV. in the eighteenth century. Berthold, however, in 1849 was the earliest to base the idea on experimental proof. This investigator removed the testes from cocks and transplanted them into new positions in the body, and he noted that the birds developed or retained their male characteristics (voice, sexual and combative instincts, growth of comb, wattle, etc.) just as though they were normal males. These results were attributed by Berthold to substances formed by the testes irrespective of their position, and thus he was the first to put on a definite experimental basis the idea of an organ elaborating a hormone which, after being carried in the circulation, acted upon other and distant parts of the body. Little account was taken of Berthold's work at the time, and it was not until much later that the conception of organs having an endocrine function was revived by Claude Bernard, who applied it to the liver. In recent times Berthold's work on the testicular graft has been confirmed for a large number of animals, and the fact that the testis, in addition to producing the semen, gives rise also to one or more chemical substances of the nature of hormones has been established.

The notion that the testis produces an internal secretion which, besides being responsible for the male characters, possesses also a rejuvenating influence, is a somewhat different one. It was originally put forward in 1889 by Brown-Séquard, who injected testicular extract, first into animals and then into himself. He was convinced that in both cases beneficial effects accrued, and claimed that he himself underwent a radical change and regained the force and vitality of former years. The extracts were made from dogs' and guinea-pigs' testes, and were injected subcutaneously. At this time, Brown-Séquard was seventy-two years old. The supposed rejuvenating effects, however, did not last, and although this form of treatment was extended to some hundreds of patients suffering from various diseases (rheumatism, sciatica, locomotor ataxia, tuberculosis, etc.) by Brown-Séquard and Brainard, who claimed that good results often followed, the practice of testicular injection was soon discontinued and became generally discredited.

In recent years, however, the idea of testicular rejuvenation has been revived in connexion with grafting experiments. In 1913, Lespinasse, an American doctor, recorded a case of testicular transplantation in a man, but gave no evidence of the persistence of the graft beyond that afforded by sexual potency. About the same time Lydston, of Chicago, is reported to have done similar work with human grafts, and the medical department of the California State Prison is said to have organised transplantation experiments in which testicles obtained from executed criminals were grafted on to senile individuals, but there is no satisfactory evidence as to the results obtained.

More recently (1918) Stanley and Kelker have performed the same operation, and in further experiments the testes of animals were substituted for human ones. It was believed, however, that in all cases the grafts became necrotic and were either absorbed or else the site of operation opened up and the necrotic material was discharged. In a later paper, Stanley has described a large number of experiments (more than 1000 had been carried out by 1922) in which men were injected with partially macerated testis by a syringe. With this method the danger of sloughing was much reduced, and the injected substance could be felt under the skin for months, but it was eventually absorbed. From these experiments Stanley concluded that animal testicular substance injected into the human body caused decided benefit for some time. Among those treated were patients suffering from neurasthenia, epilepsy, asthma, tuberculosis, diabetes, and many other chronic diseases, as well as senile decay. Most of the subjects reported increased sexual activity and resumption of virility where this had been lost. It is said, further, that testicular substance often has a beneficial effect in relieving pain of unknown origin and in promoting bodily well-being, and that the power of vision is sometimes greatly strengthened. The testicles used were those of goats, rams, deer and boars.

Three cases have been described by Lyons in which rams' testicles were transplanted on to men suffering from debility and impotence, and in two of these favourable results were claimed, but the fate of the grafts was unknown.

The above recorded experiments were all carried out in America in the last decade. In the same period, numerous operations of a similar order have been carried out in Europe. In 1915, Lichtenstern, of Vienna, operated on a soldier who had lost his testicles as a result of being wounded in the War. After a few months, the patient showed all the usual signs of

complete castration and suffered from want of vigour and general apathy. Lichtenstern then engrafted an undescended testicle from another individual, and as a consequence the symptoms of castration disappeared and the man became normal. Two and a half years later he was still normal, having been married fifteen months. Further cases of testicular transplantation in men are recorded by Lichtenstern as well as by Kreuter and Mühsam, the operation being performed for eunuchoidism and homosexuality, as well as for debility and impotence, and successful results are claimed. In none of these cases does there appear to be definite evidence as to the fate of the graft, but it would appear almost certain that it must have persisted for some time.

Voronoff, whose work on the so-called "monkey gland" has attracted so much attention, began his experiments on the testicular graft at the Collège de France in 1917. His earlier work was upon sheep and goats, in which he grafted young testes into old animals and into animals castrated before puberty. The best results were obtained by grafting the testes into the scrotal sacs, or in the case of aged animals, upon the testes already present. Retterer and Voronoff, in a paper published last summer, tell us that some of these animals are still under observation at the Laboratory of Experimental Surgery of the College and that they continue to display sexual vigour and ability to copulate. The success attending these experiments led Voronoff to attempt testicular transplantation upon aged men. In connexion with this work, two points are strongly emphasised; first, the advantage of making the graft in a suitable position and preferably the natural position of the organ; and secondly, the importance of biological affinity between the individual from which the testis is taken and the recipient of the graft; consequently, in carrying out testicular transplantation from animals to men, Voronoff selected the chimpanzee as the most suitable animal from which to obtain the graft, since of all the anthropoid apes this species is believed to be the nearest akin to man. The result of the operation in many instances is claimed to be entirely successful. The walls of the arteries are said to have become softened and the capacity for work increased, and, in short, a complete restoration of mental and muscular vigour is stated to have been attained. In the majority of men so operated upon sexual potency also is said to have been revived.

In some of Voronoff's experiments there is definite evidence concerning the persistence of the graft, and Retterer and Voronoff have described microscopic sections of graft tissue after several months of transplantation. Thus the figure of a section of a goat's testis a year after grafting shows cells which might reasonably be supposed to have had an internally secreting function, though the tissue as a whole had undergone considerable degeneration and neither spermatozoa nor interstitial cells can be detected. The authors state that the condition of the transplanted chimpanzee's testis is similar, but they do not appear to have recorded the duration of the graft. On the other hand, Thorek, an American surgeon, who has recently confirmed Voronoff in regard to the persistence and efficacy of the chimpanzee graft when made upon man, has described and supplied photographs of sections of such grafts when removed four months after transplantation, and these show an abundance of secretory cells and every evidence of active life, though the seminiferous tubules had undergone incomplete regression. The good results are attributed to a new technique whereby the vascularisation of the graft was greatly improved.

There is one point of importance on which Retterer and Voronoff differ from most physiologists, and this relates to the elements which are responsible for producing the internal testicular secretion. The bulk of the experimental evidence is strongly in favour of the view that the testicular hormone is elaborated by the interseminiferous or interstitial cells, and Steinach, who has called this tissue the "puberty gland," attributes the supposed rejuvenating effects of vasectomy to the hypertrophy of this gland, pointing out that the spermatogenetic tissue after this operation undergoes degeneration as noted by former observers. According to the French investigators, however, the testicular graft does not contain interstitial cells, the rejuvenating function being due to the epithelial cells which continue to discharge the problematical secretion into the circulation notwithstanding the fact that they become converted by poverty of nutrition into "young connective tissue." On the other hand, in Thorek's preparations, the interstitial cells have proliferated and appear to have been functionally active.

In conclusion, it must be emphasised that the work is as yet in the experimental stage. In many of the cases recorded the effects of "suggestion" are not satisfactorily excluded, and the evidence as to the persistence of a functional graft is still meagre. That the histological results are conflicting and that those of Voronoff are contrary to the usual view as to the source of origin of the hormone, are valid reasons for reserving judgment. Nevertheless, it must be pointed out that the accumulation of evidence in support of the contention that a testicular graft obtained from another individual, and even from another species, may exert a definite physiological influence upon the recipient, is considerably greater than many men of science have so far been disposed to admit.

Some Aspects of the Physical Chemistry of Interfaces.[1]

By Prof. F. G. DONNAN, C.B.E., F.R.S.

LET us now inquire how far the phenomena which are characteristic of a gas-liquid interface occur also at the interface between two immiscible or partially miscible liquids. Many years ago it was shown by Gad and by Quincke that a fatty oil (such as olive oil) is very readily dispersed in the form of an emulsion by a dilute solution of caustic soda. Some experiments which I once made showed that a neutral hydrocarbon oil could be similarly emulsified in a dilute aqueous solution of alkali if one of the higher fatty acids was dissolved in it, whilst the lower fatty acids do not

[1] Continued from p. 870.

produce a similar action. It was shown that the action runs parallel to the lowering of interfacial tension and must be ascribed to the formation of a soap, which lowers the interfacial tension and concentrates at the interface. These phenomena have been further investigated by S. A. Shorter and S. Ellingsworth, by H. Hartridge and R. A. Peters, and by others.

If a substance which is dissolved in one liquid A, and is practically insoluble in another liquid B, is found to have, in very dilute solutions, a strong effect in lowering the tension at the interface A-B, the following interesting questions arise:

(1) What is the amount of the surface concentration or adsorption per sq. cm. of interface?

(2) Can it be calculated by means of the simplified Gibbs equation?

(3) How does the surface adsorption vary with the concentration?

(4) Does the "saturation" value correspond to the formation of a unimolecular layer?

Some of these questions were experimentally investigated in my laboratory by W. C. McC. Lewis. For the liquid A water was chosen, and for B a neutral hydrocarbon oil. Working with sodium glycocholate as the surface-active substance, it was found that the experimentally measured surface adsorption q was much greater than that calculated by means of the equation

$$q = -\frac{c d\gamma}{\mathrm{RT} dc}.$$

Comparing the values with those previously obtained for the air-liquid surface, it is clear we are not dealing with simple unimolecular layers, but with adsorption layers or films many molecules thick. On the other hand, if we calculate from Lewis's results the surface area per molecule as deduced from the surface tension measurements by the simplified Gibbs formula, we arrive at values which are consistent with the gradual building up of a unimolecular layer (of possibly heavily hydrated molecules or micelles). It is possible, therefore, that the Gibbs equation gives the surface concentration of the primary unimolecular "two dimensional" surface phase, and that any building up of further concentrations beyond this layer does not affect the surface tension. In a later investigation Lewis determined the surface adsorption of aniline at the interface mercury-aqueous alcoholic solution, and found in this case a very fair agreement between the observed and calculated results. This case is more favourable, since we can be in little doubt concerning the molecular weight of the solute units. We may conclude, therefore, that Lewis's measurements in this case point to the building up of a primary unimolecular layer, unaccompanied by any further concentration or "condensation" of molecules or colloidal micelles.

Experiments similar to those of Lewis have been very recently made by E. L. Griffin, who has measured directly the adsorption of soaps from aqueous solutions at a mineral oil-water interface. The results obtained are as follows:

Substance.	Average Surface per Molecule adsorbed.
Sodium Oleate	48×10^{-16} sq. cm.
Potassium Stearate	27×10^{-16} sq. cm.
Potassium Palmitate	30×10^{-16} sq. cm.

These figures are very interesting, for they would appear to indicate the formation of unimolecular surface layers.

We have seen that in the case of the air-water surface there exists an electrical separation or potential difference in the surface layer, and that certain substances can produce pronounced variations, or even reversals in sign, of this electrical double layer. It becomes a matter, therefore, of great interest to inquire whether similar phenomena occur at the interface between two immiscible liquids, and, if so, to ascertain whether such electrical charges or double layers bear any relation to the "stability" of pure emulsions, or fine dispersions of one liquid in another. It is well known that those disperse or finely heterogeneous states of matter known as colloidal solutions depend in part for their stability on the existence of such electrical potential differences. We might expect, therefore, that an investigation of these emulsion systems would throw some light on the general theory of what are called "suspensoid" or "lyophobic" colloidal states.

Investigations with these objects in view were carried out some years ago in my laboratory by R. Ellis and F. Powis. The method employed was to measure directly by means of a microscope the motion of minute globules (suspended in water) under the influence of a known electric field. From the measured velocity and potential gradient, the interfacial P.D. and the electrical charge can be calculated from the theories of Helmholtz, Lamb, and Stokes. The microscopic method has the advantage that the P.D. between the aqueous solution and the glass wall (cover glass or object glass) can be determined simultaneously. It is a remarkable fact that the P.D. between various types of hydrocarbon oils (purified from acid so far as possible) and water was found to be 0·045-0·053 volt, the oil being negative—that is to say, the oil droplet moving towards the anode. If we compare this with the value recently calculated by McTaggart for the P.D. between an air-bubble and water (deduced from a precisely similar type of measurement), namely 0·055 volt, we can draw the conclusion that the potential difference is due to an electric double layer residing in *the surface layer of the water*. The oil droplet moves, therefore, with an attached negative layer or surface sheet, probably determined by hydroxyl ions, this being balanced by a positive layer the charge of which is determined by hydrogen ions.

Perhaps the most remarkable result which has emerged from these electrical investigations of oil suspensions is the relation between the stability of the emulsion and the potential difference of the interfacial double layer. The minute oil globules are in constant Brownian motion and must frequently collide. Why do the forces of cohesion not produce agglomeration or coalescence (coagulation or clearing of the emulsion)? At distances great in comparison with their own dimensions the electric double layers will act practically as closed systems. But when two oil drops approach sufficiently near each other the conditions will be different, since we must expect a repulsive force when two similarly charged outer layers just begin to interpenetrate each other. Hence the answer to the question asked above is that the third factor is the potential difference or electric density of the interfacial double

layer. Other things being equal, the probability P of an encounter leading to coherence will be a diminishing function of the electric intensity π of the similarly constituted double layers, *i.e.* $dP/d\pi$ will be negative. Hence, of the total number of encounters in a given small period of time, the number which lead to coherence should be a maximum at the point of zero potential difference (iso-electric point of Hardy).

Now the experiments of Powis brought out the very important fact that when the interfacial P.D. (whether positive or negative) is above a certain value, which was about 0·03 volt for his conditions, the rate of coagulation or coherence of the oil drops is relatively small, but rapidly increases when the P.D. falls inside the zone $-0{\cdot}03$ $+0{\cdot}03$ volt. Under definite conditions there exist, therefore, what we may, speaking broadly, call a *critical potential* and a *critical potential zone.* When the P.D. is outside this zone the emulsion is comparatively very "stable." Very small concentrations of electrolytes, which, as we have seen, increase the P.D., increase this stability. As soon as the concentration of any electrolyte is sufficient to bring the P.D. into the critical zone, the stability of the emulsion undergoes a sudden and very marked decrease, and relatively rapid coagulation occurs. Take, for example, the case of thorium chloride. On increasing the concentration we find that the interfacial P.D. traverses successively the following regions:

(1) Above the critical value (and negative).
(2) Inside the critical zone (negative and positive).
(3) Above the critical value (and positive).
(4) Below the critical value (and positive).

In exact correspondence with this series we find that the emulsion goes through the following states:

(1) Stable (oil particles "negative").
(2) Unstable and flocculating (oil particles negative or positive).
(3) Stable (oil particles positive).
(4) Unstable and flocculating (oil particles positive).

Here we see a very striking analogue and explanation of the phenomena observed by Joly in studying the effect of aluminium salts on the sedimentation of clays, and of the numerous examples of the so-called "irregular series" observed in the flocculation of suspensoid hydrosols by salts with polyvalent cations.

As Linder and Picton showed, when two suspensoid hydrosols, one negative and the other positive, are mixed, then, depending on the ratio, a stable hydrosol (either positive or negative) can be obtained. In continuation of this work, W. Biltz demonstrated the existence in such cases of a "zone of coagulation," *i.e.* a zone of concentration ratios leading to coagulation. A study of the mutual behaviour of a negative oil emulsion and the positively charged ferric oxide hydrosol provides a complete explanation of this curious phenomenon. When increasing amounts of the iron oxide hydrosol are added to the oil emulsion, it is found that the interfacial P.D. falls to zero, and then reverses its sign, becoming increasingly positive—an action which is due to the adsorption of the positively charged micelles at the oil-water interface. When the P.D. is above a certain value (positive or negative) the system is stable. But within the critical zone a rapid and relatively complete mutual coagulation takes place.

These studies of oil emulsions (and of the glass-water interface), by means of the micro-cataphoresis method, have thrown a great deal of light on many previously ill-understood points in the theory of colloids. The following table contains the concentrations (in millimols per litre) of certain electrolytes required to reduce the potential of a certain hydrocarbon oil emulsion from its "natural" value (against pure water) of 0·046 volt to the critical value, 0·03 volt:

——	Concentrations.	Ratios of Concentrations.
KCl	51	2500
$BaCl_2$	1·9	95
$AlCl_3$	0·020	1
$ThCl_4$	0·0070	0·35

These results show the enormous influence of the valency of the cation in a series of salts with the same univalent anion, and explain in a striking manner the analogous effects in the coagulation of lyophobic hydrosols. The exact value of the critical potential and the range of the critical zone will depend, of course, on the experimental definition of "rapid coagulation," and on the concentration, nature, and degree of dispersion of the hydrosol. It is not to be supposed, therefore, that these critical values are constants except under very definite conditions. The fundamental fact is that under given conditions the rate of coagulation of the particles of an oil suspension or of a lyophobic hydrosol undergoes a relatively sudden and very great increase when the interfacial P.D. falls below a certain finite value (positive or negative).

In discussing the "stabilities" of hydrocarbon oil emulsions, it must not be forgotten that I was dealing with very dilute *suspensions* of oil in water, produced by mechanical agitation without the addition of any "emulsifier." I pointed out that in the emulsification of oils in water by means of soap, the soap lowers the interfacial tension and concentrates at the interface. When we wish to produce oil emulsions in the ordinary sense of the term, we must use some such emulsifying agent, and for this purpose many substances are employed, such as soap, gum acacia, gelatin, casein, starch, etc., etc. All these substances concentrate or condense on the surfaces of the oil globules. If we may regard these surface films as very mobile from the molecular-kinetic point of view, it is clear that they will confer an increased degree of stability on the emulsion.

It is probable, however, that the stability of the emulsion is in many cases due to the fact that the surface films possess a very viscous, quasi-rigid, or gel-like character, so that a more mechanical explanation is necessary. As S. U. Pickering showed, oils may be emulsified in water by the gels of certain basic salts; and A. U. M. Schlaepfer has shown that emulsions of water in kerosene oil may be obtained by means of finely divided "carbon." Nevertheless, even in cases where an emulsifier is used, we may hope to succeed in obtaining a more precise physical analysis of the system. It is interesting in this connexion to note that Mr. W. Pohl has recently found in my laboratory that when a neutral hydrocarbon oil is emulsified in

water by means of sodium oleate, the electrical potential difference at the oil-water interface is almost doubled, and that the effects of alkalies and salts on this potential difference are very similar to those found in the case where no emulsifier is employed.

I cannot conclude this account of certain aspects of surface actions and properties without making a passing, though all too brief, reference to the beautiful investigations of Sir George Beilby on the amorphous layer. He has shown that when the surface of crystalline matter is subjected to shearing stress there is produced a surface layer of a vitreous or amorphous character—a "flowed" surface—in which the particular ordered arrangement of the molecules or atoms which is characteristic of the crystalline matter largely disappears. Working at University College, London, Dr. Travers and Mr. R. C. Ray have recently obtained a very interesting confirmation of the Beilby effect. The heats of solution (in kilogram calories per gram mol) of vitreous silica and silver sand (silica as crystalline quartz) in aqueous hydrofluoric acid were found to be 37·24 and 30·29 respectively. After grinding for fifteen hours the corresponding values were 36·95 and 32·46 respectively. If we assume that the internal energy of the amorphous phase produced by grinding is the same as that of the vitreous silica (silica glass), we can calculate from these results that about 31 per cent. of the crystalline silica has been converted by grinding into "amorphous" silica. The densities of silica glass and silver sand were found to be 2·208 and 2·638 respectively. After fifteen hours' grinding the density of the latter was lowered to 2·528. On the same assumption as before, it follows that about 26 per cent. of the quartz has been converted into the vitreous condition. The difference between the figures 31 and 26 is doubtless due to the approximate character of the assumption underlying the calculations and to experimental errors. There seems little doubt, however, about the soundness of the main conclusion—namely, that the mechanical action of shearing stress on crystalline matter is to produce a random molecular or atomic distribution in the surface layers.

Obituary.

Mr. J. M. Wilkie.

Mr. John Matthew Wilkie died on November 29 after an operation. He was born at Montrose in 1876, and was educated as a pharmaceutical chemist; after passing his minor in Edinburgh he went to Derby and later to London. In 1900 he was appointed as an assistant analyst, and eventually deputy chief analyst, in the laboratory of Boots Pure Drug Co., where he remained until his death.

Perhaps the best known of Mr. Wilkie's researches were the estimation of small quantities of lead, published with Mr. Harvey, the silver methods for the determination of phosphoric acid, and the alkaline iodine oxidation of phenols, the last two researches being published in the journal of the Society of Chemical Industry. He also devised a most ingenious method for the estimation of sulphur and oxidised sulphur compounds, which depended on the formation of acid by the bromine oxidation, but this research has only been published in abstract, as he was never quite satisfied that he brought it to a satisfactory completion. These sulphur oxidation methods have, however, been in use at Messrs. Boots' laboratory for some years with most satisfactory results. The last four years of his life was devoted to an almost monumental research on the determination of minimal quantities of arsenic. Step by step he patiently investigated the points of the method, and at the time of his death his work was concluded, and he was engaged in putting his notes into order for publication. This research was given to the world in abstract at the joint meeting of the Society of Public Analysts with the Nottingham Section of the Society of Chemical Industry at Nottingham on January 17 last.

As secretary to the Nottingham Section of the latter society from 1914 to the present year, he was largely responsible for the success of that Section and the great increase in the membership. He had just become chairman of the Section, and, although he had only presided at one meeting, he signalised that by inaugurating a discussion in which a large number of young members were persuaded to take part. It was always Wilkie's policy to encourage and bring forward young talent, so much so that at Mrs. Wilkie's special request he was borne to his last resting-place by the young men that he used to encourage and talk about so often.

The issue of *Science* of November 23 contains an appreciative account, by "H. H. W.," of the life and work of Prof. Robert Wiedersheim, the distinguished professor of anatomy in the University of Freiburg, who died on July 12. Wiedersheim was born on April 21, 1848, at Nürtingen-am-Neckar, and went in succession to the Universities of Tübingen and Würzburg. At Würtzburg he obtained his M.D. and became assistant professor under Köllicker (1872–76). In 1876 he went to Freiburg as assistant to Prof. Alexander Ecker, whom he succeeded as professor of anatomy in 1887. This post he held until he retired from active work in 1918. Wiedersheim's work lay in the fields of human and comparative anatomy. In 1882 he published his "Lehrbuch der vergleichenden Anatomie der Wirbeltiere," following up this work with the "Grundriss der vergleichenden Anatomie," covering the same ground in a more concise manner. The last edition of the latter, the seventh, appeared in 1909. A modified translation of the "Grundriss," by Prof. W. N. Parker, was published in 1886 by Messrs. Macmillan and Co., Ltd. He also published a number of monographs, among which "Das Kopfskelet der Urodelen," that on the ear of the Ascalaboten, the anatomy of *Salamandrina perspicillata* and *Geotriton fuscus* are best known. With his death an outstanding figure in the history of the comparative anatomy of vertebrates has passed away.

We regret to announce the following deaths:

Mr. George Wharton James, of Pasadena, California, known for his work on American Indian ethnology, on November 8, aged sixty-five.

Prof. H. Freeman Stecker, professor of mathematics in the Pennsylvania State College, a worker in non-Euclidean geometry, on October 30, aged fifty-six.

Current Topics and Events.

DR. G. D. LIVEING, who reaches his ninety-sixth birthday on Friday, December 21, may be assured that, in addition to the many personal friends who offer him congratulations on the maintenance of activity and intellectual interest at so great an age, chemists and other men of science, not only in Great Britain but also abroad, think of him with affection and esteem. He has had a remarkable life, and his contributions to scientific knowledge will long remain a permanent testimony to his care in experiment and caution in conclusion. Dr. Liveing went to St. John's College, Cambridge, was eleventh Wrangler in 1850, and in the following year was placed at the top of Class I. in the newly instituted Natural Sciences Tripos. He was elected to a fellowship at St. John's College in 1853, and became professor of chemistry in the University in 1861, a post which he filled until 1908. His name will always be associated with the growth and development of the Chemical Laboratories of the University. In 1879, Dr. Liveing was elected a fellow of the Royal Society, of which he was vice-president for two periods, 1891–2 and 1903–4. He was awarded the Davy medal in 1901 for his contributions to spectroscopy, and in making the presentation, the president of the Royal Society referred to Liveing's work as "one of the most valuable contributions to this department of chemical physics yet made by British workers." The work on spectroscopy was given to the world in numerous papers in the Proceedings of the Royal Society and the Cambridge Philosophical Society, and was brought together in 1915, in collaboration with the late Sir James Dewar, under the title "Collected Papers on Spectroscopy." Dr. Liveing holds the unique distinction of having been in residence at Cambridge for more than seventy-five years in unbroken succession, and his figure is probably well known to most living members of the University.

PROF. KLEINE of Berlin, who has just returned to Europe, has been investigating the therapeutic properties of a drug known as "Bayer 205" in Rhodesia and the Congo in cases of human sleeping sickness and trypanosomiasis of domestic animals—diseases which are such a serious handicap to the development of Africa. It is well known that salts of arsenic and antimony are able in many cases to control these diseases, but these remedies are far from satisfactory, and the remarkable results which were reported in Germany in 1922 in the treatment of experimental trypanosomiasis in animals and in dourine of horses with the new drug "Bayer 205," the composition of which has not yet been made public, aroused much enthusiasm. The completely satisfactory treatment of a human case in Hamburg, after arsenic and antimony had failed at the Liverpool School of Tropical Medicine, excited considerable interest. Other patients were treated at the London School of Tropical Medicine, and it became evident that in many cases the drug had a rapid action on the trypanosomes, and, so far as can be said at present, has effected a permanent cure. The one disadvantage is a certain irritative action on the kidneys, which, however, is not of a permanent nature. Prof. Kleine was granted permission by the British Government to conduct experiments in Rhodesia, and the published accounts of his work show that the hopes which were entertained were fully justified, and that cures can be effected in a large percentage of natives suffering from sleeping sickness even in its advanced stage. As regards the trypanosomiasis of domestic animals, he has noted that it is only efficacious in ridding them of trypanosomes which are most closely related to those which produce disease in man. Experiments on the prophylactic action have shown that if cattle which are to be exposed to the bites of tsetse flies are given an injection of the drug before exposure, the chances of infection are reduced, and even if infection does occur its course is considerably modified. It is understood that Prof. Kleine will, in the near future, give an account in London of his experiences.

IN some cases the American graduate appears to receive a farewell address of the nature of a "pastoral charge" before he leaves the university to make his own way in the world. Such an occasion obviously encourages platitudes, but we may be grateful that the issue of *Science* for October 19 enables Prof. Millikan's address to a graduate class at Stanford University, California, to reach a wider public. He recalls that Senator John Sherman, when addressing a class of graduates in 1891 in which Millikan was included, told them their problem was to make democratic government work in a country three thousand miles one way, by two thousand the other, a government and a country which had been preserved to them by the sacrifices made to them by his generation. Now, as the result of untold sacrifice, 1923 finds the world, by no means yet ready for the task, presented with the problem of making democracy work on a huge scale, not only in the United States of America but also in almost every important nation on earth. Prof. Millikan finds that one of the greatest contributions that science makes to the problem is the discovery that progress is in general made by the evolutionary process. "The whole of Newton is incorporated in Einstein." He decides that if bullets are to be replaced by ballots it will only be "because the nations of the earth learn to take a more rational, a more objective, a more scientific attitude towards life and all its problems." . . . "For in the jungle ignorance and prejudice and impulse and emotion must determine conduct, and so long as that is the case none other save the law of the jungle is possible." Prof. Millikan has no nostrum to propose to eliminate the jungle influence, but looks to "the slow growth of a larger degree of both public intelligence and public conscience than we now have. Intelligence enables one to know better what he ought to do, while conscience keeps him doing as he knows he ought." He concludes that "science, imbued with the spirit of service, which is the essence of religion, and religion guided by the intelligence, the intellectual honesty, the objectiveness and the effectiveness which is char-

acteristic of the spirit of science, can between them, without a shadow of doubt in view of the rate at which discoveries are now being made and at which changes are being brought about, transform this world in a generation."

At a recent meeting of the Zoological Society, Mr. R. T. Gunther exhibited some vertebræ of a marine Jurassic crocodile, Steneosaurus, which were marked on the sides with discoloured grooves apparently due to contact with blood-vessels. In a letter to the *Times* of December 7, he reported that a dissection of the intercostal arteries of a modern crocodile by Mr. R. H. Burne had confirmed this idea, and he suggested that the unusual markings may have been produced by some calcification of the arteries due to a gouty condition, perhaps in old age. As the appearances are almost unique, Mr. Gunther has presented one of the vertebræ to the Geological Department of the British Museum, where it is now exhibited. The discovery led Prof. Elliot Smith, in a letter to the *Times* of December 12, to recall observations of blood-stains on human bones from Egypt and Nubia, from 4000 to 5000 years old, made by Prof. Wood Jones and himself. In a subsequent letter to the *Times*, Mr. Reid Moir advises caution in interpreting red or brown stains on fossil bones as marks of blood, most of these being evidently due to the deposit of oxides of iron by percolating water.

The Library of the Chemical Society will be closed for the Christmas holidays from Monday, December 24, until Thursday, December 27, inclusive.

Sir Charles Sherrington has received an official communication from the Institut de France informing him that he has been elected a corresponding member of the Section of Medicine and Surgery of the Paris Academy of Sciences, in succession to the late Sir Patrick Manson.

The Christmas Juvenile Lectures at the Royal Institution, "Concerning the Nature of Things," to be delivered by Sir William Bragg, commence on Thursday, Dec. 27, at 3 o'clock. Succeeding lectures are on Saturday, Dec. 29, Tuesday, Jan. 1, Thursday, Jan. 3, Saturday, Jan. 5, and Tuesday, Jan. 8.

The Board of Trade announces that by virtue of the Importation of Plumage (No. 2) Order, 1923, the green (or Japanese) pheasant (*Phasianus versicolor*), order Galliformes, and the copper pheasant (*Phasianus Soemmerringi*), order Galliformes, have been removed from the schedule to the Importation of Plumage (Prohibition) Act, 1921. The importation of the plumage of the above-mentioned birds will, therefore, not be permitted without licence on and after January 1, 1924.

The *Illustrated London News* of December 15 publishes an account by Mr. R. C. Andrews of the discovery of eggs of deinosaurs in the Cretaceous rocks of Mongolia, with excellent photographs of some of the specimens. To emphasise the fact that at least one egg attributed to a deinosaur has been known for many years, it also publishes a photograph of fragments of this egg which have long been in the British Museum. The earlier specimen was found with part of the skeleton of Hypselosaurus in an Upper Cretaceous formation in Provence, France, and the outer surface of the shell is tuberculated like that of the new eggs.

The following committee has been appointed by the Royal Academy to investigate the quality of artists' materials and the various methods of cleaning old pictures: Sir Aston Webb, Mr. S. J. Solomon, Mr. G. Clausen, Mr. C. Shannon, Prof. A. P. Laurie, Sir Herbert Jackson, Sir Arthur Schuster, Dr. A. Scott, Mr. C. F. Cross, Dr. W. W. Taylor, Dr. R. S. Morrell, Mr. N. Heaton, Mr. P. Tudor-Hart, Mr. J. D. Batten, and Mr. F. E. Jackson.

In the notice of a "scientific novel" in Nature of September 1, p. 320, Mr. H. G. Wells was mentioned as the first to exploit in imaginative literature the idea of liberating the energy of the atom. Prof. W. A. Osborne, of the University of Melbourne, thinks this is incorrect, and remarks in a letter to us, "I should not be surprised if the first use in fiction of the possibility of unlocking atomic energy occurred in 'The Crack of Doom,' by the late Mr. Robert Cromie. This story was published in 1895 by Digby Long, and shortly afterwards a cheap reprint appeared from the house of Newnes."

A series of articles on the reconstruction of Tokyo has recently appeared in the *Times* (December 12, 13, and 15). The total value of the houses destroyed in the city is estimated at about 146 million pounds, the number of houses lost being 224,567, of which more than 97 per cent. were burnt. According to Prof. Ichikawa, fire broke out after the earthquake in the building adjoining the University Library. The water supply had already ceased, and, although every effort was made to screen the various rooms, the fire swiftly penetrated into them, the destruction of the library and the greater part of its contents being the work of a few moments.

The Prince of Wales has consented to become the first member and president of the Fellowship of the British Empire Exhibition, a non-party organisation which has been formed to promote Empire unity. The subscription for membership, two guineas, entitles the member to a certificate of membership, a badge, and a season ticket to the Exhibition at Wembley. The funds thus raised are to be devoted to scholarships for university or technical education, each of the value of 1000*l*. No details are given of the conditions of awards except that candidates must be citizens of the British Empire and either members of the Fellowship or nominated by members. In accepting the presidency of the Fellowship, the Prince expresses the hope that its programme of Imperial education and settlement scholarships will play a valuable part in promoting knowledge of the Empire.

In addition to the letter from Dr. H. H. Mills, printed in last week's Nature, page 865, we have received several others in which different views are expressed upon Mrs. Hertha Ayrton's scientific work and influence from those given by Prof. Henry E. Armstrong in the obituary notice which appeared

in our issue of December 1. One of the subjects especially referred to is the anti-gas fan, of which it is pointed out that more than 100,000 were used during the War. As, however, a full discussion of this device as a protection from gas attacks appeared in 1920 in vol. 105 of NATURE, pp. 336, 422, 453, and 612, and Mrs. Ayrton herself took a leading part in it, no useful end would be served by going over the same ground again. With regard to her work on the electric arc, it may be remarked that an appreciation of it appeared in the Journal of the Institution of Electrical Engineers for October last, over the initials of a distinguished authority on electrical engineering.

IN view of the high standard of the essays sent in for the R. 38 Memorial Prize, 1923, the Council of the Royal Aeronautical Society has decided to increase the amount for this year only from 25 guineas to 40 guineas, and to divide the prize between the papers on "The Aerodynamical Characteristics of the Airship as deduced from Experiments on Models, with Application to Motion in a Horizontal Plane," by Mr. R. Jones, and "A Detailed Consideration of the Effect of Meteorological Conditions on Airships," by Lt.-Col. V. C. Richmond and Major G. H. Scott. Both these papers will be published in the Journal of the Royal Aeronautical Society, together with the paper on "The Strength of Rigid Airships," by Mr. C. P. Burgess, Commander J. C. Hunsaker, and Mr. Starr Truscott, which the Council mentions as deserving special commendation. Intending competitors are reminded that the names of entrants for the 1924 prize should be sent in to the Secretary, Royal Aeronautical Society, 7 Albemarle Street, London, W.1, on or before Dec. 31; the last date for the receipt of the papers is March 31, 1924.

THE annual exhibition of the Physical Society of London and the Optical Society, which is to be held on Wednesday and Thursday, January 2-3, at the Imperial College of Science and Technology, South Kensington, will be open in the afternoon (3-6 P.M.) and in the evening (7-10 P.M.). Mr. H. B. Grylls will give a lecture on "The Heape and Grylls Rapid Cinema Machine" at 4 P.M. on January 2 and at 8 P.M. on January 3. Sir Richard Paget will give a lecture on "The Nature and Artificial Production of Human Speech (Vowel Sounds)" at 8 P.M. on January 2 and at 4 P.M. on January 3. More than fifty firms are exhibiting scientific apparatus, and a number of experimental demonstrations have been arranged. Invitations have been extended to the Institutions of Electrical and Mechanical Engineers, the Chemical Society, the Radio Society of London, the Röntgen Society, and the Faraday Society. Admission in all cases will be by ticket only, and members of the above Societies should apply to their secretaries. Others interested should apply direct to Prof. A. O. Rankine, hon. secretary of the Physical Society, Imperial College of Science and Technology, South Kensington, S.W.7.

SCIENTIFIC work in Egypt has just lost a strong supporter owing to the retirement of Mr. E. M. Dowson from the post of Financial Adviser to the Egyptian Government. This post is the highest in the Egyptian Government Service open to a non-Egyptian. Mr. Dowson joined the Service in 1901 as a member of the Survey Department, and on the retirement of Colonel Lyons in 1909, was made Director-General. During the latter part of the War he acted as Under Secretary of State for Finance and later as Financial Adviser, to which post he was definitely appointed in 1919. Having been head of a scientific department he knew the importance of scientific research to the progress of a country and fostered it in every way he could. Of the work carried out under his direction one may mention the geodetic triangulation of Egypt and the precise levelling of the Nile valley. He was also responsible for a number of improvements in the organisation of scientific work under the Egyptian Government, including the formation of the Cotton Research Board and the transfer of the Physical Service to the Ministry of Public Works as a separate department.

A USEFUL piece of work has been done by the British Industrial "Safety First" Association in issuing a revised and extended version of the illustrated pamphlet by Mr. Leon Gaster on "Good Lighting as an aid to Safety." The underlying principles of good lighting are based on a great deal of patient scientific work and somewhat complex investigations, but the main conclusions are here set out in quite simple terms and are illustrated by many telling sketches and photographs. There are, for example, pictures showing how various forms of accidents may be caused by bad lighting, and charts indicating how the frequency of industrial accidents is greatest during the dark winter months. Examples of improved output following the adoption of scientific methods of lighting are quoted, and it is pointed out that the cost of adequate illumination is usually less than 1 per cent. of the cost of production. Reference is also made to lighting conditions in mines and on the railways. The chief recommendations of the Home Office Departmental Committee on Lighting in Factories and Workshops are explained, and the classification of operations into two classes, "fine work" (requiring not less than 2-ft.-candles, and "very fine work" (requiring not less than 5-ft.-candles), is incorporated in the booklet as an appendix.

IN consequence of the existence of the Colorado beetle in France, and in order to prevent the introduction of this dangerous pest into England and Wales, the Ministry of Agriculture and Fisheries deemed it necessary in the early part of 1923 to issue an Order (the Colorado Beetle Order of 1922) which in effect prohibited the entry into Great Britain of living plants and vegetables grown in a wide area in France. Following representations made to the Ministry, and as a result of the visit of investigation to the infected region in France which was made by the Ministry's entomologist during the autumn, it has now been decided to amend the regulations. The Colorado Beetle Order of 1923 has accordingly been issued and came into operation on December 17, revoking the corresponding Order of 1922. The effect

of this new Order will be that in place of the declaration required at present, each consignment of living plants, potatoes, or tomatoes shipped from ports in European France to Great Britain must in future be accompanied by a particular certificate or copy certificate, which must be delivered to an Officer of Customs at the same time and together with the entry relating to the consignment. In future no certificate or declaration of any kind will be required in the case of vegetables for consumption other than potatoes or tomatoes.

A SERIES of articles on "Science and Industry in America," from the pen of Dr. W. Rosenhain, has recently appeared in the *Engineer*, and in the concluding article, on October 26, the author sums up his impressions derived from visits to a large number of scientific and industrial laboratories in North America. It is remarkable that the enormous development of certain laboratories devoted to industrial research, whether under the management of a commercial body, such as the General Electric Co., or of a Government department, such as the U.S. Bureau of Standards, has noticeably had a paralysing effect on the universities, some teachers of science imagining that it is useless for them, with limited equipment, to enter into competition with such great institutions. Such an impression, as the author remarks, would be most unfortunate if it were to become general. The employment of so many competent physicists and chemists in industry has to some extent injured the scientific staffs of the universities, and the standing of the men in charge of teaching and research is not always as high as might be expected from the wealth and population of the country, and from the vast sums expended on buildings and equipment. On drawing up a list of the most eminent men in various branches of scientific investigation, the proportion of Americans is disappointingly small, when the resources of the country are taken into account. This attitude of America towards science and its applications is recognised and deplored by American men of science themselves, and it is a subject of speculation how long it will take so great a nation to awake to the necessity of a change in this respect.

BULLETIN No. 717 of the Department of the Interior, Washington, is on "Sodium Sulphate: its Sources and Uses," by R. C. Wells. This pamphlet deals with the mineral forms of sodium sulphate together with salt cake, nitre cake, and Glauber's salt. The sulphate process of making wood pulp is also described. The booklet is well illustrated with diagrams of crystal forms, equilibrium diagrams, etc.

WE have received from the Canadian Department of Mines a copy of a report on titanium by A. Robinson. The three parts into which the book is divided deal with the metal and its compounds, its occurrences in Canada, and the production and uses of the metal respectively. The book is well illustrated with maps and diagrams. The uses to which titanium and its compounds may be put are fully discussed. These include its use in the metallurgy of steel, arc light electrodes, pigments, mordants, and in the ceramic industry.

Our Astronomical Column.

MERCURY AN EVENING STAR.—Mercury will be visible to the naked eye on a few evenings at the end of December, the planet being above the horizon more than $1\frac{1}{2}$ hours after sunset. At about 5 P.M., Mercury will be visible on very clear evenings a little above the W.S.W. horizon, shining with a rosy light and scintillating after the manner of a fixed star. The brilliant planet Venus will be situated about 8° to the eastwards and afford a clue to the exact position of Mercury, which will shine with far less lustre. A field-glass might be employed to advantage. Early in January, Mercury will disappear from the evening sky, but Venus will remain very conspicuous in the twilight during the ensuing winter and spring months.

THE EINSTEIN SHIFT IN THE SOLAR SPECTRAL LINES. —Allusion was made in this column recently to the announcement of Prof. C. E. St. John that he was satisfied that this shift really exists. He gave further details in a paper read at the meeting of the Royal Astronomical Society on December 14; in his previous researches he had felt it necessary to confine himself to lines that are not subject to pressure shift. But now that the pressure in the photosphere is proved to be low, the choice of suitable lines for measurement is greatly widened. In studying the wave-lengths of iron lines at the centre of the sun's disc and at different levels in the photosphere, he finds a shift in excess of Einstein at the highest levels, in agreement with Einstein at the middle levels, and in defect at the lowest ones; these could be explained by downward and upward currents in the respective regions, superposed on the general Einstein displacement. He also found the latter displacement at the sun's limb; here, too, some other influence was superposed on it; scattering due to the greater thickness of solar atmosphere traversed by the rays was suggested. Mr. Evershed expressed himself in full agreement with the conclusions, but Prof. Newall thought the evidence was still not decisive, as many other disturbing influences were at work on the sun, *e.g.* the Stark effect, polarisation and anomalous dispersion; the observed displacement might be due to these.

FIXED CALCIUM CLOUDS IN INTERSTELLAR SPACE.—Mr. J. S. Plaskett has made an examination of the radial motion indicated by the calcium lines in some Cepheid stars of early type which have been found not to partake of the periodic shift of the other spectral lines. It has for some time been considered that these stars are surrounded by calcium clouds. It is now found that these clouds in various regions of the heavens appear to be stationary relatively to the general system of the stars. The clouds would thus seem to be independent of the particular stars showing the lines, and it was suggested at the meeting of the Royal Astronomical Society on December 14 that there might be a general diffusion of calcium vapour throughout the stellar system, but that in most stellar spectra its presence is masked by the strong H and K lines belonging to the stars themselves. Various difficulties were referred to in the discussion. Some thought that the clouds would be luminous and show bright lines; another difficulty is the practically perfect transparency of the stellar spaces which Dr. Harlow Shapley deduced from his work on the globular clusters. The subject is still somewhat obscure.

Research Items.

EARLY HITTITE RECORDS.—Valuable additions to our knowledge of the early history and political relations of the peoples of Western Asia are made by Prof. Sayce in the concluding part of *Ancient Egypt* for the current year, which has just appeared. Prof. Sayce translates some of the early cuneiform Hittite tablets, recently published by Dr. Forrer, which relate the campaigns of Sargon of Akkad and Naram Sin in Asia Minor. Naram Sin's enumeration of seventeen kings who formed an alliance against him includes rulers of cities in Babylonia, Northern Syria, and Eastern Asia Minor, and proves the intimate connexion which existed between all parts of Western Asia in the third millennium B.C. From one of the Boghaz-Keni tablets, in a record of a later King Telibinus, we now learn that the leader of the Hittite invasion of Babylonia, about 1900 B.C., which overthrew the Amorite dynasty of Khammurabi, was Mursilis I. Telibinus also gives a list of the cities over which he ruled, including Damascus. This is the earliest mention of this city in cuneiform tablets. It indicates that the Hittite sovereignty extended southward as far as the northern boundary of Palestine, and explains how Hittite settlers found their way to Hebron in the time of Abraham.

MATHEMATICAL WORK OF JAMES GREGORY.—In vol. xli. of the Proceedings of the Edinburgh Mathematical Society, Prof. G. A. Gibson gives a critical and historical account of the work of James Gregory. To the ordinary student of mathematics, Gregory is now known almost solely as the man who first used the phrase "converging series" as a technical term, and as the author of the series for $\tan^{-1}x$. The latter series is comparatively unimportant, not a fundamental series like Taylor's, and it is very unlikely that it would have been associated with Gregory's name but for the part it played in the Newton-Leibniz controversy. Yet all contemporary references to Gregory show that he was considered to be among the first mathematicians of his day, quite apart from his fame as the author of the "Optica Promota." Undoubtedly the books he published were of sterling merit, though comparatively few references to them exist in modern mathematical literature.

AL-RAZI [RHAZES] AS A PIONEER CHEMIST.—In No. 3-6 of vol. xliv. of the *Deutsche Literaturzeitung* (Berlin, 1923), Prof. Julius Ruska, of Heidelberg, has an article on the contributions to chemistry of the Persian physician Al-Razi (died A.D. 923 or 932). He points out that a satisfactory history of Islamic medicine and chemistry is still lacking, and remarks that it is necessary to get back to the texts themselves. According to Prof. Ruska, Al-Razi's chemistry, as found in his "Book of the Secret of Secrets," is characterised by the inclusion of a good deal of new material unknown to the Greek alchemists, and also by the classification of chemicals into three classes, according to their origin from animals, plants, or minerals. Prof. Ruska attributes to Al-Razi in addition (*a*) the introduction of sal-ammoniac, and (*b*) the first systematic and well-organised treatment of particular chemical reactions; here, however, he is inaccurate, since Jabir ibn Hayyan (died about A.D. 813) mentions sal-ammoniac very frequently, noting both the natural product and that made from hair, and also devotes several small books to a consideration of such operations as calcination, distillation, sublimation, etc. As Al-Razi was certainly well acquainted with Jabir's books, it is clear that a great deal of the credit for the pioneer work to which Prof. Ruska refers must be given to the latter chemist. It is interesting to note how modern research is restoring to the Muslims the great reputation for chemical skill which they possessed for so long, though it suffered heavily in the latter half of the nineteenth century.

PHYTO-PATHOLOGY IN HORTICULTURE.—The *Gardener's Chronicle* for November 3 contains, under the general title "The Relation between Horticulture and Phyto-Pathology," the first instalment of a paper by Prof. Johanna Westerdijk, read at the International Horticultural Congress at Amsterdam in September last. Dealing with problems of unusual difficulty, this paper seems to be singularly clear and precise, and is none the less valuable for its frank recognition of the numerous lacunæ in our scientific knowledge of the life-history and method of spread of many important horticultural diseases. The present instalment contains a wealth of data upon two important problems—(1) the need for sterilisation of seeds in the case of certain diseases and the methods adopted in various countries in such processes of sterilisation; (2) the successful growth of plants in "sick" soils by the genetic selection of resistant strains.

TREES OF THE GOLD COAST.—The Bulletin of the Imperial Institute, volume 21, No. 2, 1923, contains an interesting account of the trees of the Gold Coast, which is based upon information supplied by Dr. J. M. Dalziel, senior Sanitary Officer of the Gold Coast, and illustrated by four excellent photographs. The trees described occur mainly in the deciduous forests of what is sometimes called the Sudan zone of vegetation. From the forestry point of view the trees are not of great value, but they have many local uses for timber, fibre, gums, and fuel, etc., while the fat of the shea-butter tree (*Butryospermum Parkii*) gives to the open park-savannah forests considerable economic value.

OCEANOGRAPHY OF THE JAVA SEA.—A gap in the oceanographical knowledge of the waters of the Malay archipelago has been filled by the researches of Mr. K. M. van Weel in the Java and South China seas from 1917 to 1920 (Meteorological and hydrographical observations in the western part of the Netherlands East Indian Archipelago: *Treubia*, vol. iv. pt. 1-4, 1923). The lengthy memoir is accompanied by a portfolio of 28 distributional charts. The floor of the Java Sea is shown to slope gently downwards from Sumatra towards the east, barely reaching a depth of 100 metres to the west of Macassar Strait. East of the 100 metre isobath the depths appear to increase suddenly, but this is outside the area of Mr. van Weel's survey. A remarkable feature is a deep channel in Sunda Strait between Sumatra and Java. An erosion channel caused by a strong current moving out of the Java Sea suggests itself, but this explanation does not fit the facts. Mr. van Weel is disinclined to regard it as a tectonic chasm as has been suggested, and leans to the belief that it represents the sunken valley of a large river. He accepts Molengraaff's pleistocene continent on the site of the Java and China seas, and regards the Sunda submarine channel as a submerged feature of that land. All hydrographical as well as a number of meteorological observations are given in full.

RIVER POLLUTION.—The pollution of the River Tyne, and its deleterious effect on the salmon fisheries

is the subject of a well-written paper by Miss E. M. Meek in the report of the Dove Marine Laboratory for 1922–23. Fifty years ago the salmon fisheries of the Tyne were more than ten times as prosperous as they are to-day, and almost conclusive evidence is now given to show that the decline of this industry is due to sewage pollution. The paper is of general interest since it is illustrated by a series of curves correlating the effect of sewage contamination upon the oxygen content of the water. The result of an experiment on *Zoarces viviparus* indicates that the toxicity of the sewage is directly due to foreign substances in the sewage and not to the reduced oxygen content of the water. It would be interesting to know to what extent sewage must be diluted in order that this fish can continue to breed under experimental conditions; also, what is the direct effect, if any, of the reduced oxygen supply.

BOUNDARIES IN THE UNITED STATES.—Bulletin No. 689 of the United States Geological Survey is a complete account of the boundaries, areas, geographic centres and altitudes of all States in the United States, including oversea possessions. It is a revised and enlarged edition of a bulletin that was first published in 1885 and has been republished with additions several times since that date. A brief introduction discusses how boundaries are established and changed, but the greater part of the volume deals with the boundaries of the different States. Full details of the present position of the boundaries and of all past changes are given, with detailed references to treaties and other State documents. In addition to a number of sketch maps, there is a large reproduction of the second edition of the Mitchell map of the British and French dominions in North America as printed in 1774 or 1775. This was the map that was used in forming the peace treaties of 1782 and 1783, for in spite of its imperfections it was the best available at the time. A coloured map shows the routes of the principal explorers from 1501 to 1844 in the territory now covered by United States jurisdiction. The publication contains a great deal of valuable material for the study of the evolution of boundary lines and frontiers.

PHILIPPINE EARTHQUAKES.—The Philippine archipelago is one of the most active seismic regions in the world; yet, near its centre, lies the long narrow island of Cebu, in which, for the last four centuries, almost the only earthquakes felt have come from outside. On this account, the earthquakes that may be considered as belonging to it are of interest, if only in showing that historic time may be too brief to reveal all the areas of seismic change. One earthquake that caused slight damage in Cebu occurred in 1887, and a second on February 28, 1922. The latter is the subject of a brief report by the Rev. M. Saderra Masò, the historian of Philippine earthquakes (Bulletin of the Weather Bureau, Manila, for February 1922). The area of damage included the capital city Cebu and the small island of Mactan to the east. In the channel between the islands, beneath which the origin probably lay, unusual movements of the sea were observed, and on the same day, but at an unknown hour, the cable crossing it was broken.

SUB-SURFACE GEOLOGY IN OILFIELDS.—Until the last few years, sub-surface structural analysis in oilfield work tended to be a very haphazard process. Too often subterranean structures have been described in terms of mapped surface evidence, and methods of correlation of well-log data have been in the main of a somewhat crude character, until the technique of palæontology and petrology was acquired in dealing with the evidence adduced from drilling operations. Some recent reports of petroleum geologists attached to the United States Geological Survey have shown that the necessity for more detailed work of this character is now fully appreciated, and a great deal of minute investigation is being prosecuted in this connexion. It is therefore somewhat of a surprise to see that in the case of the sub-surface study of the Pershing oil and gas field, Osage County, Oklahoma, the author, Mr. W. W. Rubey, has adopted methods depending almost entirely on drillers' reports, graphic well-logs, field-statistics, and the like, rather than the more highly technical and certainly more convincing methods of study. It is open to doubt as to how far graphical methods of interpreting oil-well behaviour lead to really important evidence which may be used as a basis of deduction of subterranean conditions and as a guide to the future course of developments of the oilfield concerned. As criteria of geological circumstances, individual or even collective oil-well performances are of doubtful value if studied without reference to as comprehensive a knowledge of the unexposed rocks as possible. It is not to be expected of the average driller that he is trained in even the elements of lithology; his terminology is necessarily crude and in many instances untrustworthy. It is for the geologist to analyse and name the samples, just as it is his business to use those results for precise correlation below ground. Thereafter, by co-ordination of such evidence and all other statistical data furnished during the life-history of each well, he is in a position to supply the operators with all the information necessary to economical development of the field as a whole.

RAINFALL IN SUMATRA.—The Royal Magnetic and Meteorological Observatory at Batavia has recently published, in Verhandelingen No. 11, a summary of rainfall in the northern part of "Sumatra's Oostkust," by Dr. J. Boerema. The observations are made at the official rainfall stations and the figures are not used unless they cover a period of at least 5 years. There are 288 stations available and in addition 22 stations in Atjeh and 4 in Tapanoeli. Monthly and annual results have been calculated for a normal period of 20 years. Maps for the year and for each month show the areas of equal amounts of rainfall for practically the whole country; also the months of maximum and minimum rainfall. It is estimated by discussion that a monthly mean rainfall calculated from 5 years' observations may differ to the extent of 40 to 50 per cent. from the average obtained from a long series of observations, say 35 years; in the case of 10 years' observations, the deviations are reduced to about half that value. For 30 years the difference from the 35-year normal is only 3 per cent. The rainfall increases from the coast to the mountains, the annual map showing a general rainfall of about 60 to 100 inches near the north-east coast to about 150 to 260 inches in the mountains. An annual average of 263 inches is given at Bandar Baroe. The rainiest season is October and November, with a secondary maximum in April and May. The double tropical periods of rainfall are scarcely disturbed by the monsoons. The minimum rainfall occurs in February and June. Statistics are given of the monthly and annual amount and frequency of rainfall at all stations. More than ordinary interest is associated with the carefully worked results since Sumatra is divided by the equator and falls about equally in the Northern and Southern Hemispheres. Such discussions are of the highest value to the world's meteorology.

HEAT CONDUCTION IN LIQUIDS.—In the issue of the Proceedings of the American National Academy of Sciences for October 15, Prof. P. W. Bridgman, of Harvard, gives a summary of the results of his measurements of the heat conductivities of 15 liquids at 30° and 75° C., and at pressures up to about 12,000 atmospheres. The liquids were placed between two concentric metal cylinders, to the inner of which heat was communicated electrically and the difference of temperature of the two measured. For all the liquids tested, with the exception of water, the conductivity decreases as the temperature rises, and increases with rising pressure. For the more compressible liquids the conductivity at a pressure of 12,000 atmospheres is nearly three times that at atmospheric pressure. If the transfer of energy from molecule to molecule is assumed to take place with the speed v of sound in the liquid, the thermal conductivity should be $4v/d^2$, where d is the distance apart of the centres of consecutive molecules. This relation is shown to be satisfied approximately.

FIRING WITH PULVERISED COAL AND BLAST FURNACE GAS.—The firing of coal in a pulverised condition, that is, 90 per cent. through a 100 mesh screen (100 holes to the linear inch) and 65 per cent. through a 200 mesh, is attracting some attention in Great Britain. In the United States about 30,000,000 tons of coal per annum is being burnt in the pulverised condition, chiefly in the iron and steel, cement, and glass industries. Since 1920 the rapid growth in the application to steam generation has been remarkable, and very soon about 3,000,000 tons per annum will be absorbed in this one operation, although little or no progress has so far been made in Great Britain. One advantage of pulverised coal is that it will work in conjunction with blast furnace gas. In the operations of the blast furnace a large volume of low-grade gas is given off, averaging 90-110 B.Th.U. per cubic foot, with a composition of about $24\frac{3}{4}$ per cent. carbon monoxide, $5\frac{3}{4}$ per cent. carbon dioxide, $2\frac{1}{4}$ per cent. hydrogen, $\frac{3}{4}$ per cent. methane, and $66\frac{1}{2}$ per cent. nitrogen. As a rule the surplus gas is burnt on very crude lines under steam boilers, and because of the great fluctuations in the supply, generally coal has to be used as an auxiliary fuel. This gives bad results, since it is difficult to keep pace with the variations in the gas supply. For these conditions, however, pulverised fuel is good, since it is almost as easy as gas to regulate and adjust, and can be started up or shut down in a few minutes. A good example of this principle is the huge River Rouge power plant of the Ford Motor Co. at Dearborn, Detroit, where 70 per cent. blast furnace gas and 30 per cent. pulverised coal is burnt without difficulty. It has been stated that by neglecting this means of utilising blast furnace gas, Great Britain is at present wasting more than 1,000,000 h.p.

THE EARTH'S ELECTROSTATIC FIELD.—In the September issue of *Terrestrial Magnetism and Atmospheric Electricity*, Dr. S. J. Mauchly reviews the evidence now available as to the daily variation of the potential gradient in the air over both land and sea. The land observations were made at nearly 20 stations between Cape Thordsen in latitude 78° north and Cape Evans in latitude 77° south, and the ocean observations on board the magnetic observing ship *Carnegie* in the Pacific, Atlantic, and Indian oceans. Dr. Mauchly finds that as a first approximation the gradient varies daily from 80 or 90 volts per metre at 4 o'clock to 110 or 120 volts per metre at 18 o'clock Greenwich mean time at all land and sea stations. There appears to be some variation of the magnitude of the daily change and of the time at which the maximum gradient is attained, with the season of the year and with the locality, but these are not sufficient to invalidate the general conclusion. In mid-Pacific and at land stations during June and July, a reduction of the amplitude of the daily change makes it evident that there is also a 12-hour wave, but the observations are not yet numerous enough to justify conclusions being drawn as to its nature and its generality.

SYNTHESIS OF BENZENE.—The classical experiment of Berthelot on the polymerisation of acetylene to benzene, made so far back as 1858, was a fundamental synthesis of benzene, and is still quoted in the textbooks. The yield of benzene and allied hydrocarbons, however, was so small that much experimental skill was necessary to prove their presence. The results were not greatly improved by the use of catalysts, the main action in all cases being the decomposition of the acetylene into its elements. In the *Comptes rendus* of November 5 of the Paris Academy of Sciences, N. D. Zelinsky describes experiments on the polymerisation of acetylene in the presence of activated wood charcoal at 640° to 650° C. Under the conditions described, more than 70 per cent. of the weight of the acetylene passed over the charcoal was converted into liquid products. From this liquid absolutely pure synthetic benzene (303 gm.) was obtained, and other substances isolated from the condensate included toluene, *p*-xylene, styrol, indene, naphthaline, fluorene, and anthracene.

SCOTT-STILL MARINE ENGINES.—A great deal of experimental work on the Still engine has now been done by Messrs. Scotts' Shipbuilding and Engineering Company of Greenock, and their experience has enabled the firm to consider the application to actual vessels. The m.s. *Dolius* is now fast approaching completion, and is the first in which a large-scale installation of Scott-Still engines has been fitted. In this system the cylinder on one side of the piston is used as an oil engine (two-stroke Diesel cycle) and on the other side as a steam engine. The water in the jackets is kept at working steam pressure, and any heat passing through the cylinder walls is used to generate steam. Heat is also recovered from the exhaust gases by means of a regenerator, and also by a feed heater. The m.s. *Dolius* is 400 ft. long and has a displacement of 11,650 tons. The total power of 2500 b.h.p. is divided between two main engines of four cylinders, each 22 in. diameter and 36 in. stroke, and running at 115 to 120 revs. per min., giving a ship speed of about 11 knots when fully loaded under service conditions. Steam is generated at about 140 lb. per sq. in., and is first employed at the back of the piston in one cylinder acting as a high-pressure piston, and then is taken to the other three cylinders, which together act as the low-pressure cylinder. Official trials of the engines have been made by the Marine Oil Engine Trials Committee appointed by the Institutions of Mechanical Engineers and Naval Architects. Their report has not yet been issued, but the following summary is available: Average mean effective pressure, oil engine, 77·8 lb. per sq. in.; average m.e.p. steam cycle referred to oil engine volume, 6·6 lb. per sq. in.; total average m.e.p., 84·4 lb. per sq. in.; revs. per min., 122; total indicated horse-power, 1425; brake horse-power, 1251; mechanical efficiency, 87·8 per cent.; oil consumption per b.h.p. per hour, 0·356 lb.; steam evaporated per hour, 2400 lb. An account of the engine, with photographs and drawings, appears in *Engineering* for November 23.

The British Empire Exhibition, 1924.

WIDESPREAD interest throughout the British Empire and elsewhere was aroused by the Imperial Conference, attended by statesmen and representatives from the constituent parts of the Empire, which recently concluded its sittings in London. Among the subjects dealt with at this historic gathering was the natural resources of the Empire and their exploitation, and practical expression to many of the points raised will be given by the British Empire Exhibition to be held next year at Wembley. During the summer months, from April until October, the Exhibition will be a centre of attraction throughout the British Empire and indeed throughout the world. The immediate object will be to furnish a display of the natural resources of the countries of the British Empire and the activities, industrial and social, of their peoples; the ulterior motive is the promotion of Imperial trade. In effect, it should be an impressive spectacle demonstrating the progress of civilisation.

The scheme for a British Empire Exhibition was put forward in 1913 by the late Lord Strathcona, but it was not until 1919 that definite steps were taken to promote such an exhibition. A provisional committee secured the approval of the Board of Trade, the King graciously consented to become patron, and in June 1920 the project was formally launched at a meeting held at the Mansion House. The Prince of Wales became president of the general committee, and in December 1920 an Act of Parliament was passed authorising the Government to contribute to the guarantee fund, and the Dominions Overseas were formally invited to take part in the Exhibition. A site of 150 acres, since increased to 200 acres, was selected at Wembley, and work was commenced.

The magnitude of the part in the Exhibition which will be taken by the Dominions Overseas can be gathered from the following figures: at the Paris Exhibition of 1900, they had 60,000 sq. ft.; at the White City in London in 1908, 110,000 sq. ft.; at Wembley they are having 600,000-700,000 sq. ft. of space. Most of the Dominions are building pavilions to display their exhibits. Australia is spending a quarter of a million pounds on its display; the Indian Empire, about 167,000*l.*; New Zealand, a minimum of 60,000*l.*; and the other Dominions, amounts in accordance with their size. The building for Australia alone covers 150,000 sq. ft., while the Government of India has occupied 100,000 sq. ft.

Other noteworthy buildings within the grounds are the Palaces of Industry and Machinery, and the agriculture section, which will house the Home Country exhibits, and a building for the conferences which are to be an important feature of the Exhibition. To turn to a lighter side, there is a sports stadium about one and a half times the size of the Coliseum at Rome, which will accommodate 125,000 spectators, and an amusement park where the usual exhibition amenities will be provided. All the principal buildings of the Exhibition are of a permanent and substantial nature, and it is hoped that the site will be the home of future large-scale exhibitions.

The British Empire Exhibition is itself of the nature of a company, and the funds necessary for the organising work and construction have been advanced by banks on the security of the guarantee fund. It is hoped that the receipts from gate-money, sale of space in the Exhibition, and other sources of revenue, will render it unnecessary to call on the guarantors. At the close of the Exhibition, the property will be vested in a body of trustees to administer as a site for exhibitions, and any profits obtained, subject to a first charge in favour of the guarantors should it have been necessary to call upon them, is to be devoted to public objects.

In order that the Exhibition may fulfil its purpose—to display the natural resources of the British Empire and the activities of its people—it is obvious that a wide range of exhibits must be included. To all, the general condition is attached that, if manufactured, they must have been manufactured mainly within the Empire, or, if raw materials, they must have been produced within the Empire. To organise such a vast and varied collection is a task of no mean order. For this purpose the exhibits have been divided into 10 sections, 45 groups, and 150 classes. Among the section headings are food, which includes agriculture, fisheries and food-products; raw materials, including minerals and forest products; education, science and art, including the several grades of education and human, animal, and plant diseases of the tropics. Groups in other sections are devoted to aeronautics, telegraphy and telephony, chemical plant, dyes, instruments, hygiene and sanitation, and social economy. More than thirty committees have been appointed, each consisting of experts in a particular subject or branch of industry, to deal with the exhibits. In some cases, the organisation of exhibits has been undertaken by recognised trade associations; *e.g.* the British Engineers' Association is arranging the general engineering section, the British Electrical and Allied Manufacturers' Association the electrical engineering section, the Society of Motor Manufacturers and Traders the motor transport section, and the Association of British Chemical Manufacturers the chemical section. Pure science exhibits are being arranged by the Royal Society and the Association of British Chemical Manufacturers, the latter body having undertaken the whole of the pure chemistry side.

The chemical section itself will be a self-contained hall with about 40,000 sq. ft. of floor space within the Palace of Industry, and the chemical manufacturers' association is spending 100,000*l.* on it. The bulk of the space will be devoted to exhibits from the leading firms of chemical manufacturers in Great Britain, which will be arranged roughly in five groups: (1) heavy chemicals, (2) dyestuffs and intermediates, (3) fine chemicals, (4) soap and perfumery, and (5) scientific. One small section within the Chemical Hall, 2500 sq. ft. in area, will be devoted to pure chemistry, and it is hoped to demonstrate here the body of scientific research on which the chemical industry of Great Britain rests. The organisation of the scientific section is in the hands of a committee of representatives of scientific societies interested which was recorded in our issue of November 3, p. 665. This committee and the Royal Society's committee on scientific exhibits have three members in common, and in this way it is hoped to avoid overlapping.

It will not be possible in the space available for the scientific section to attempt a complete, standing exhibit illustrating the achievements of modern chemistry. The difficulty is to be overcome by providing a succession of exhibits which will follow one another during the period while the Exhibition remains open. For this purpose, the subject has been broken up into a number of sections or branches, and distinguished authorities in the various branches are arranging appropriate displays which will be "staged" in succession. A list of the names of those who have agreed to act in this capacity was given in NATURE of November 10, p. 700. In connexion with the work of the scientific section, a number of descriptive pamphlets indicating the nature

and purpose of the various exhibits will be available, and it is hoped to be able to publish a volume, each chapter of which will be contributed by an authority on the subject discussed, recording in more technical language the state of chemical knowledge at the time of the Exhibition. This volume should be a veritable milestone in the history of chemistry, and should prove a source of information and inspiration for scientific workers for years to come.

The onus of the success or failure of the whole of the chemical exhibits has been accepted by the Association of British Chemical Manufacturers; and now that arrangements are nearing completion, the Association has adopted the courageous policy of giving wide publicity to its doings. Statements have been issued to the Press, and scientific journals with an interest in chemistry have been provided with more detailed information. This has doubtless done much to arouse interest, especially in the scientific world, in the display which is to represent chemistry and chemical industry at Wembley.

The Royal Society's committee on scientific exhibits at the Exhibition is faced with a difficult task. The progress of British science in all its branches, with the exception of chemistry and allied parts of physics, has to be demonstrated impressively and effectively in a space of 2200 sq. ft., by means of a grant from the Government through the Department of Overseas Trade. Here again the field has been divided up into a number of parts, each of which has been put into the hands of an authority. The first classification consists of a primary group (mathematics, astronomy, and physics), and a secondary group (meteorology, geology, metallurgy, engineering, and aeronautics). In each subject there will be (*a*) exhibits and demonstrations illustrating current research, (*b*) instruments, and (*c*) historical material, if space permits. Instruments will be shown mainly from the National Physical Laboratory and the leading instrument makers, while the historical material, consisting of portraits, historical apparatus, and so on, will be drawn mainly from the Science Museum and the Royal Institution.

In organising the pure science exhibit, the aim of the Royal Society's committee has been not to show a mere group of apparatus, but to take some new law or principle, to trace its history, and demonstrate the consequences of its discovery. Thus, to give an example, one series of exhibits will illustrate the discovery and subsequent history of the electron. Starting from the work of Sir William Crookes, illustrated by some vacuum tubes showing the cathode rays and the other consequences of an electric discharge in a vacuum, we shall pass to the researches of Sir J. J. Thomson and the discovery of the electron as a definite entity moving with great velocity, carrying a fixed charge of negative electricity, and having the same mass whatever be its source. This work leads on to the discharge of ions from hot bodies, and the early experiments of Guthrie and the work of O. W. Richardson, on which most of the known laws governing that discharge are based. Then will come the original experiments of Fleming, the phenomena observed in an electric lamp, the discovery of the thermionic valve and its use as an amplifier of wireless waves, and in many other directions.

The National Physical Laboratory is responsible for a section on measuring instruments, illustrating much of its important work in the maintenance of standards of all kinds—thermal, up to temperatures of 2000° C., and electrical, from the currents and voltages used in ordinary practice to those at radio frequency of some 500,000 to the second. On the engineering side there will be exhibits to illustrate recent work on the measurement of stress in solids, the phenomena of fatigue, and the nature of the relative motion of the molecules of a crystal when subject to strain. Wherever possible, the exhibits will take the form of demonstrations, the whole object of the committee being to avoid a "museum" of instruments. The biological exhibits will be selected to indicate some aspects of the progress that has been made in zoology, botany, and physiology, and the varied nature of modern researches in these subjects. There will also be exhibits showing recent results of the study of adaptation, variation and heredity, sex-determination, the physiology of development, etc.

Finally, arrangements are being made for a series of short lectures by scientific workers in connexion with the Exhibition. In short, an attempt is being made to present pure science to the world as a living and progressive subject, and to demonstrate the high value of the work which has been carried out and is still going on in the scientific laboratories of the Empire.

In addition to these purely scientific exhibits, there will be sectional exhibits dealing with the application of science to industry. These will be in the hands of a committee of the Department of Scientific and Industrial Research, acting on behalf of the various Research Associations. Such exhibits will be grouped with their related industries, which will provide the necessary funds as part of their general exhibits. Government research organisations will not have separate exhibits except in so far as they illustrate the working of particular industries such as mining and agriculture; their contributions will go with the pure science exhibit organised by the Royal Society committee.

Reference was made above to what may be termed a Congress Hall, which includes four conference halls with appropriate committee rooms, etc., capable of seating 2142, 550, 180, and 150 persons respectively. A small committee, under the chairmanship of Sir Lawrence Weaver, is making arrangements with various bodies which are organising conferences to be held at the Exhibition. Among the numerous important gatherings which have already been fixed, we may mention the following: an Empire Mining and Metallurgical congress under the presidency of Viscount Long of Wraxall, organised by the Institutions of Mining Engineers and Petroleum Technologists, the Mining Association of Great Britain, the Iron and Steel Institute, the Institute of Metals, and the National Federation of Iron and Steel Manufacturers, to be held during the first week of June; a textiles conference, organised by the Textile Institute, during the second week of June; a World Power conference, organised by the British Electrical and Allied Manufacturers' Association, during the first and second weeks of July; a Museums conference, organised by the Museums Association, during the third week of July; and a conference on Science and Labour, organised by the British Science Guild and the National Joint Council of the Trades Union Congress and the Labour Party, on May 30-31. These conferences will be an important phase in the activities associated with the Exhibition, and the exchange of views promoted will have effects of world-wide significance.

The British Empire Exhibition at Wembley next year will, it is true, be an epitome of the products and the activities of the British Empire. Rightly organised, it can be more. It can show the people of Great Britain, of the British Empire, and, through the numerous foreign visitors it is certain to attract, of the whole world, the progress of industry and the purely scientific work on which all industry is based, in turning to man's need and comfort the natural resources of the world.

Variations in the Level of Lake George, Australia.

On May 18, 1876, a letter appeared in NATURE from Canon R. Abbay on the subject of the changes in level of Lake George, in the south-east of New South Wales, which in the past hundred years has varied from a small swamp to a depth of 25 feet or more. We have now received from Canon Abbay a letter and a diagram showing the variations of level in the lake from 1817 to 1918. The latter, which is reproduced in Fig. 1, was drawn from information compiled by the late Mr. H. C. Russell, Government Astronomer of New South Wales, up to 1904, and since that date by the Commonwealth Meteorological Bureau. It also shows the "residual rainfall curves" for Goulburn, the nearest station, and for Sydney, 150 miles distant. A residual rainfall curve is obtained by finding the difference of rainfall for each year from the average for the whole period and adding up the differences for successive years, so that the figure plotted for any year represents the total excess or deficit of rainfall from the beginning of observations until that year. The curves show, as Canon Abbay points out, that while rainfall is evidently an important factor in the level of the lake, there must also be other influences at work.

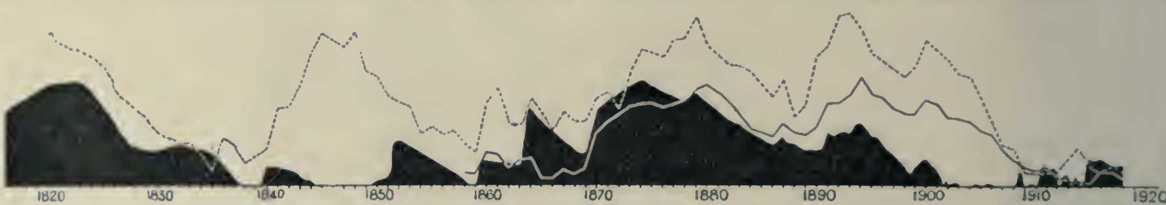

FIG. 1.—Fluctuation of water in Lake George, N.S.W. (Lat. S. 35° 4'; Long. E. 149° 23'). The fluctuations of the water in the lake as shown in black from 1817 to 1904 were compiled from various sources by Mr. Russell, and from 1904 to 1918 by the Commonwealth Meteorological Bureau.

Residual mass curve of Sydney rainfall .... Mean rainfall at Sydney for 76 years, 48·35 in.
Residual mass curve of Goulburn rainfall ———————— Mean rainfall at Goulburn for 60 years, 25·34 in.

The lake is without outlet, and we may accordingly regard its changes of level as determined by the balance between the rainfall and evaporation in its basin, the loss by seepage probably being negligible. As a measure of rainfall the long series of observations at Sydney has been employed from the commencement of the official observations in 1840. The question of evaporation is more difficult, but it has recently been found that in the Central African lakes, Victoria and Albert, the amount of evaporation bears a very close inverse relationship to the number of sunspots, the correlation coefficient between lake level (Lake Victoria) and sunspot number, after elimination of rainfall, being as high as +0·90, and much higher than the correlation with the average rainfall in the basin. In the case of Lake George, a few years of heavy rainfall and slight evaporation result in a considerable rise of level, and if they were succeeded by a series of dry hot years the lake level would fall gradually until it was dry or until another wet period supervened. It was accordingly found best to correlate the changes in level between the beginning and the end of each year (L') with Sydney rainfall (R), and average sunspot number (S), during the same year, and the following results were obtained:

Correlation between change of level and rainfall; influence of sunspots eliminated: $r = +0{\cdot}35$.

Correlation between change of level and sunspots; influence of rainfall eliminated: $r = +0{\cdot}39$.

The regression equation is:

L' (in inches) = 0·96 R (in inches) + 0·43 S (Wolf's No.).

The corresponding equation for Lake Victoria, Central Africa, was:

L (Actual level, inches from base) = 0·36 R + 0·36 S.

The years in which the lake was dry have been omitted from the calculations. The results confirm those obtained from Lake Victoria, that variations of evaporation are probably more important than rainfall variations in determining the level of lakes, and that the rate of evaporation is appreciably greater when sunspots are few than when they are numerous.

The diagram shows that the rainfall at Goulburn agrees fairly closely with that at Sydney, but if the rainfall at several stations over the lake basin had been available for a long period, there is no doubt that the correlation with their average would have been appreciably higher than that with Sydney rainfall. It also appears that the evaporation at Lake George is not determined by sunspots to the same extent as that at Lake Victoria. As Canon Abbay points out, the frequency of west and north-west winds would be of great importance in this connexion, and this would be governed by the pressure gradient between, say, Melbourne and Brisbane.

In 1875 Canon Abbay thought that the rise in the lake, which had proceeded fairly steadily from about 1849 until that date, was connected with the destruction of "bush," allowing the rainfall to run into the basin with little loss, but the subsequent fall in level showed that this could not be the cause, since the destruction of the bush continued while the level of the lake was falling. The nineteen-year periodicity which has been advocated in connexion with Australian weather occurs in the lake levels, though not very definitely, and there is also an eleven-year periodicity connected with the sunspot effect. The two chief maxima in the level, about 1821 and 1875, and the two chief periods when the lake was dry, about 1848 and 1905, are separated by intervals of 54 to 57 years, and may represent a quasi-periodicity of about 56 years caused by the interference of these two periodicities; but weather cycles are treacherous things, and it would not be safe to base a forecast on them. C. E. P. B.

Geological Progress in India.

It is satisfactory to notice that, in spite of financial stress in India, the Government has continued to add to the staff of the Geological Survey, which, with the recruits recently selected, now includes 26 out of the sanctioned 30 officers of the senior grade. The progress of work also during the last few years, since the return to normal duties of those officers who were on active service, has resulted in an approach to completion of many lines of work that had been for some time necessarily left indefinite. Among these the classification of the Tertiary beds of Burma, and their correlation with the Tertiaries of Western India and the standard stratigraphical scale of Europe, are now showing distinct signs of stability.

The untimely death of Mr. E. Vredenburg (NATURE, April 14, p. 505) prevents the completion of the heavy task of summarising the palæontological results, but

the papers which he has published already, together with the work especially of Dr. G. de P. Cotter, are sufficient to permit of a satisfactory classification of the Burma Tertiaries, the correct correlation of which is of great importance to the petroleum industry of the province. Of the distinct steps forward, one of the most important has been recognition of the precise nature of the lateral variation in facies, especially that from north to south, in consequence of the progressive rise and silting of the meridional marine gulf which existed to the east of the Arakan hills in early Tertiary times. Extended mapping of the formations shows how freshwater formations in the north pass southwards into beds of marine origin, while estuarine and littoral beds pass into those of more settled marine origin. The papers of Messrs. Vredenburg and Cotter published in the Records of the Geological Survey (vols. li. and liv.) bring together the main results of this work expressed in tabular form, and additional details have just been issued in a posthumous paper by Mr. Vredenburg (vol. lv., part 1, 1923).

The correlation of the Burma Tertiaries with other areas has been based mainly on marine fossils, but, meanwhile, most valuable studies of the vertebrate remains included in freshwater beds have been carried on by Dr. G. E. Pilgrim. Most of this has been in connexion with the younger Tertiaries of the famous, but, as it proves, not entirely well-known, localities of the west and north-west. Recent work in the Punjab Salt Range shows that some revision of the correlation tables will be necessary, and that it will be possible, when the newly discovered vertebrate remains are studied, to correlate by direct fossil evidence the lower and middle Siwaliks of the Salt Range with those of the Himalayas.

The director's report of the Survey for 1922, just issued by Dr. E. H. Pascoe in the Records, describes, besides a summary of Dr. Pilgrim's most recent work, some interesting results in other parts of India, in addition to those separately noticed in previous pages of NATURE. Among these, an interesting discovery of true Gondwana coal has been made in the Southern Shan States, indicating a Jurassic or Rhætic age, corresponding to a part of the upper division of the Gondwana system in India and some of the coal beds of Tonkin.

Considerable additions have also been made recently to our knowledge of the Deccan trap and of the dykes through which the lava attained the surface. Recent work by Mr. H. Walker in the Tapti valley reveals the interesting fact that the river, for more than 30 miles in an east-west line, follows a fault valley, roughly parallel to the general tendency to rifting which Sir Thomas Holland referred to in his presidential address to Section C (Geology) of the British Association at the meeting in Australia (NATURE, vol. xciv., September 3, 1914, p. 8) as a preparatory condition for the outflow of the Deccan lava sheets.

Another feature of general interest arises from the long-delayed analyses of brines from the Sambhar lake in Rajputana. The economic question which led to a special investigation of this lake 20 years ago arose from the observation of the salt-manufacturing officers that the lake showed signs of depleted resources and consequently possible loss as a source of Government revenue. The investigation undertaken in 1903 by the Geological Survey showed that, while the total amount of sodium chloride stored in the silt rendered nervousness on this account unnecessary, there was a possibility that the continual removal of pure chloride as salt and the consequent increase in the proportion of residual carbonate and sulphate among the soluble salts might increase the difficulty of customary manufacture by fractional crystallisation. A methodical system of sampling was then undertaken annually from various parts of the lake, and Dr. W. A. K. Christie has recently analysed the products. A summary of his results shows that there was a small but definite deterioration in chloride as the result of ten years' work in extracting salt between 1907 and 1916. Taking the two five-year periods to tone out annual variations, the ratio of chloride to other soluble salts in the lake brine has dropped from 86·09 : 13·91 to 85·38 : 14·62. In the brines obtained from the sublacustrine silt the corresponding ratio has fallen from 83·18 : 16·82 to 81·07 : 18·93. Arrangements have been made for resuming the annual sampling of the brines; for unless a system be devised for recovering some of the other salts, the value of the lake as a source of salt will cease long before there is any approach to exhaustion of the total supplies.

Palæontology at the American Museum of Natural History.

THE researches of the palæontological department of the American Museum of Natural History for the years 1918 to 1921 have now been issued as a volume, making the seventh in the series. In all there are twenty-three papers, contributed by Prof. H. F. Osborn, Dr. Matthew, Dr. Gregory, Messrs. Granger, Mook, Von Huene, Miller, Gidley, and Camp. Prof. Osborn describes some new Titanotheres, mostly primitive forms, from the Huerfano, and in two other papers continues his studies on the Proboscidea. One is an account of some American mastodons, and the other is important as giving his views to date on the evolution, phylogeny, and classification of the elephant group as a whole. Dr. Matthew, in addition to faunistic papers, continues, with Mr. Granger, the review of the faunas of the Eocene deposits of the United States. The papers by Messrs. Gidley and Miller are faunistic. There is a series of ten papers by Mr. Mook on crocodiles, recent and extinct; a paper by Mr. Von Huene on reptilian and stegocephalian remains in the Cope collection; and three by Dr. W. K. Gregory, one of them in collaboration with Mr. Camp, which are continuations of his studies on the comparative myology and osteology of vertebrates.

In considering these contributions to our knowledge of palæontology, for the value of which the authors' names are a sufficient guarantee, it will be noticed that the bulk of them are continuations of previous studies, and are designed to attack definite problems. Such, for example, is the series by Dr. Gregory on the muscles and bones, where various parts are compared one by one and worked out in a most systematic manner. These papers will form a mine for other workers. In the same spirit is Mr. Mook's intensive study of the crocodiles and Prof. Osborn's on the elephants.

The volume is a worthy memorial to the energy and devotion of the president and staff of the museum, and the museum without doubt gains from this advertisement of its activity. If the publications by members of the staff of the palæontological department of the British Museum for a similar period were gathered together, it is probable that they would make a worthy companion volume, but, being widely scattered in several publications, the public has never the opportunity to discover this fact.

It may further be noted that, in the period covered by these communications, the American Museum from its palæontological department alone sent six expeditions into the field as far as China, India, and Cuba, as well as in the States themselves.

University and Educational Intelligence.

BIRMINGHAM.—The degree of D.Sc. has been conferred on Mr. C. S. Fox for a thesis on "The Bauxite and Aluminous Laterite Occurrences of India," and supplementary papers; and on Mr. B. M. Griffiths for a thesis on "The Phytoplankton of Bodies of Fresh Water, and the Factors determining its Occurrence and Composition," and supplementary papers.

CAMBRIDGE.—Mr. S. W. P. Steen has been elected to a fellowship at Christ's College.

The secretaryship of the Board of Research Studies has become vacant by the resignation of Sir Geoffrey Butler, now elected representative of the University in Parliament, who has done valuable work in steering the new scheme for the Ph.D. degree successfully past certain initial difficulties.

It is proposed, subject to the approval of the Statutory Commissioners, to bring all University officers appointed in the future under such pension scheme as shall be adopted by the University and approved by the Commissioners; and further, for the University to take powers to come to an agreement with present holders of University offices whereby they may come under the general pension scheme.

It is proposed to admit to the privileges of affiliation graduates of certain other universities who have graduated with first-class honours without the present restriction that they must have passed in English, mathematics, and Latin or Greek at one of the examinations leading to their present degree.

EDINBURGH.—On Monday afternoon, December 10, the Rt. Hon. S. M. Bruce, Prime Minister of the Commonwealth of Australia, visited the University and received the honorary degree of Doctor of Laws. Mr. Bruce was warmly received, especially by a number of Australian students, who formed a compact section of the audience and who gave their distinctive call. In a speech immediately following the ceremony Mr. Bruce emphasised the great need they felt in all the Overseas Dominions that men of university training should take increasing interest in the affairs of their respective countries. At no time in the history of Great Britain or the Empire as a whole had it been more imperative that they should have these men, with all their traditional ideas gathered in the university, to give of their services freely and willingly to the country and to set a standard of good citizenship. He appealed for renewed unity of the people, and said that "a strong and united British Empire is the greatest hope there is to-day for the future peace of the world and for the happiness and security of the whole of humanity."

SHEFFIELD.—The following appointments have been made: Mr. R. A. Morrell, to be lecturer in radiology; Mr. G. Wilkinson, to be lecturer in the history of medicine; and Dr. D. C. Barron, to be assistant-lecturer in medicine.

LONDON.—The following doctorates have been awarded: *Ph.D.* (*Science*): Prabhatchandra Sarbadhikari (Imperial College—Royal College of Science) for a thesis entitled "Cytology of Osmunda and Doodia—On the Somatic and Meiotic Mitosis of Doodia—I"; Mustapha Ahmed Abu Zahra (Imperial College—Royal College of Science) for a thesis entitled "The Mechanical and Graphical Solution of the Two-dimensional Motion of a Cylinder of a General Section in Viscous Fluid subject to Oseen's Approximation"; Hassan Sadek (University College) for a thesis entitled "Miocene Period in the Gulf of Suez Area, Egypt." *Ph.D.* (*Economics*): Emma Annie Winslow (London School of Economics) for a thesis entitled "Budget Studies and the Measurement of Living Costs and Standards."

MR. E. C. DAVIES, a distinguished student of Prof. R. M. Wild at the University of Manchester, has been appointed assistant lecturer in chemistry at the Natal Technical College, Durban, S. Africa.

SINCE our issue of December 15 the following announcements of the election of representatives of the Universities in Parliament have appeared: Oxford—Sir Charles Oman (U.) and Lord Hugh Cecil (U.); Wales—Mr. G. Davies (Lab.).

APPLICATIONS are invited by the committee of the University College Hospital for the Radcliffe Crocker travelling scholarship in dermatology, the approximate value of which is 280*l.*, tenable for a period of twelve months, to be spent at some place of study outside the United Kingdom. Further particulars may be obtained from the Dean, University College Hospital Medical School, University Street, W.C.1.

THE New York correspondent of the *Times* states that Mrs. Montgomery Ward has given 3,000,000 dollars (about 660,000*l.*) to the North-Western University, Chicago, to create a medical centre at the University to be called the Montgomery Ward Memorial. Yale University has announced that 4,000,000 dollars (about 880,000*l.*) of the 15,000,000 dollars (about 3,330,000*l.*) left to it by the bequest of John W. Sterling will be used to erect a library.

RECENT progress in vocational education in America is described in the sixth annual report of the Federal Board for Vocational Education. The enrolment in schools aided by the board has increased steadily from 164,000 in 1918 to 475,000 in 1922, in which year their total expenditures amounted to 12½ million dollars. The outstanding feature of this development has been the growth of the general continuation schools. The main purposes of this type of school are the same as those of the continuation schools provided for by Mr. Fisher's Education Act of 1918. Of the 48 states, 43 now maintain part-time schools for young persons who have left full-time schools to go to work, and 21 have enacted state-wide mandatory or permissive part-time school laws. Although the enrolment in schools of this type has increased from 53,000 in 1918 to 228,000 in 1922, this number is less than one-tenth of the boys and girls 14 to 17 years of age not attending school of any kind. One notable aspect of recent progress in the vocational school movement is its influence on the regular public day schools: "There is a new spirit in elementary education; it is the spirit of attention to practical needs." Conversely the outlook of the vocational education programme is being broadened so as to include much more than simply "specific preparation" for the technical processes of a skilled trade. Some idea of the extent to which employers recognise the value of continuation schooling may be gathered from the fact that at least 25 national associations of employers have set up organised systems of training for employees, some with endowments ranging from 2 to 10 million dollars. The Federal War Department has developed an elaborate system of testing for and teaching trades in the Army, based on a policy of fitting men not only for effective military service but also for success in civil life.

Societies and Academies.

London.

Aristotelian Society, November 26.—Prof. H. Wildon Carr in the chair.—J. W. **Scott**: The incidence of mathematico-physical speculation on philosophy. Mathematical speculation upon philosophical questions is especially forceful at two places—the theory of the infinite and the theory of appearances and their relation to reality. The naïve conception of the infinite has been a common problem for philosophers and mathematicians alike. Kant declares that we can prove with equal cogency that space or time both must be and cannot be infinite; and Galileo points out that an infinite number is a number such that the number of numbers making it up is the same as the number of numbers making up a contained part of it. Philosophers and mathematicians alike do not stop at the difficulty of the naïve conception. For each there is a false as well as a true conception of infinity, and their definitions are curiously alike. The essence of infinity consists for the mathematician in a certain relation between the whole and its parts, and for the idealist philosopher infinity is only to be ascribed to wholes which are self-contained, such as works of art. The other problem, namely, the problem which of the contradictory appearances of a sense-perceived object is the real appearance of the thing, may be solved along the same lines. Perspectives sum into a container. The unity either of a thing or of a sensum is the unity of an infinitude; and an infinitude is something in some sense self-contained.

December 3.—Prof. T. P. Nunn, president, in the chair.—Dorothy **Wrinch**: On certain aspects of scientific thought. Many important scientific hypotheses embody the assumption that certain properties are irrelevant to each other. They may be grouped together as "irrelevance postulates." Thus in the quantum theory there is an important hypothesis to the effect that the energy of a bundle of radiation given off by an atom of matter to the ether, divided by the frequency with which it manifests itself to the spectroscope, is always an integral multiple of a universal constant h. The assumption states that this ratio h has the same value, irrespective of all physical and chemical properties of the matter which emits the radiation. Also other "constants of Nature" such as the charge carried by an electron, the velocity of light, the universal constant of gravitation, correspond each to a "postulate of irrelevance." Einstein has suggested a postulate of irrelevance of a still more radical kind in his assumption that the laws of Nature are invariant with respect to systems of co-ordinates which satisfy certain very general conditions. In the generalised theory of relativity these are the Gaussian systems.

Royal Anthropological Institute, November 27.—Mr. H. J. E. Peake in the chair.—E. H. **Hunt**: Hyderabad cairn burials and their significance. Cairn burials with stone circles are found scattered over the whole of South India. Their numbers indicate that important persons alone could have received this form of burial, and the civilisation represented must have held full sway for a prolonged period. Pots are found inside and outside cists. Body positions are commonly "contracted," though "extended" and "urn" burials are found, and burnt bones. Iron is found constantly, but iron affords no evidence of date in India. Surface denudation of more than fifteen feet of hard soil in places and disintegration of granite slabs in the absence of salt afford evidence of considerable age. History shows that these burials cannot date later than Asoka in any case. Vedic writings are silent. There is a curious series of similarities with early Egypt: (1) Cultivation by irrigation; (2) orientation of graves; (3) burials; (4) polished black and red pots, red pots on ring stands, and pot marks, *e.g.* the "KA" mark; (5) lapis beads, a stone foreign to Egypt, and probably also to India. Parallel with these resemblances an equally striking series of differences can be made out, such as the absence of stone circles in Egypt, though boulders abound.

December 4.—H. **Balfour**: On certain aspects of the technology of the Nagas of Assam. The field-observations recorded were made during a three-months tour through the Naga Hills in company with Messrs. J. H. Hutton and J. P. Mills, resident officials of the I.C.S., in the winter of 1922, during which some 50 or 60 native villages were visited. The prevailing system of "dry" cultivation by *jhuming*, as contrasted with the elaborate intensive system of "wet" terrace-cultivation practised almost exclusively by the Angami, has had devastating effects upon jungle-growth. Among the Ao Nagas, when fire-making is practised for divination or taking omens, it is not necessary to obtain a spark. The ordinary process is followed of sawing a bamboo thong round a stick, but the latter need not be split as it invariably is for ordinary fire-making. When the thong breaks the broken ends are carefully studied, and the omen is taken from the nature of the fracture. This use of an *unsplit* stick for divination has not before been recorded. A type of fish-trap is used, not before described from the Naga Hills, the chief interest of which lies in its almost continuous dispersal from this area through the Malayan and Indonesian regions to Melanesia, affording a valuable culture-link between the extremes of its geographical range. This culture-link is further emphasised by the loom and by other items, which together throw light upon the route followed by culture-dispersal within this wide area. The carved "figure-heads" embellishing the huge monoxyle dug-out gongs of the Ao Nagas are conventionalised representations of the head of the water-buffalo. An account was given of "bull-roarers," recently discovered by Messrs. Hutton and Mills to exist in this region.

Royal Microscopical Society (Industrial Applications Section), November 28.—Sir Kenneth Goadby in the chair.—J. E. **Barnard**: The characteristics of a microscope for general and special purposes. The tests for mechanical efficiency that should be satisfied.—S. H. **Browning**: The application of the microscope to industrial diseases.—C. A. **Newton**: The microscope in the examination of condensed milk. If a film of sweetened condensed milk be examined at a magnification of from 50 to 100 diameters, the sugar it contains can easily be seen. The sugar crystals afford an indication of the good quality of the milk; if they appear clean and well defined, the milk will keep well, while in bad milk, or milk likely soon to become bad, there appears also an acicular crystallisation of the milk sugar. Sweetened condensed milk in its normal state is too dense or too opaque for examination by the higher powers of the microscope necessary to observe any micro-organisms likely to be present. Diluting with nine parts of distilled water, a thinner film is available, and in the case of bad milk it is then easy to see yeast cells (causing milk to become "blown"), and other micro-organisms if any are present.

Linnean Society, November 29.—Dr. A. B. Rendle, president, in the chair.—C. C. **Lacaita**: The Onosmas of Linnæus and Sibthorp, with a note on those of

Tournefort's herbarium.—M. D. **Zalessky**: On new species of Permian Osmundaceæ. An extension of Kidston and Gwynne-Vaughan's work on the anatomy of Permian Osmundaceæ from Russia. Ferns of this affinity in Permian times had a solid wood in the stem, differentiated into an outer zone of normal tracheides and an inner core of short, wide elements The leaf-trace, on its outward course, changes from mesarch to endarch structure. The anatomy is described in *Bathypteris rhomboidalis* (in which the stele was previously unknown), in two new species of Thamnopteris (*T. Kidstoni* and *T. Gwynne-Vaughani*), and in a new species of Zalesskya (*Z. uralica*) which may be a young state of *Z. gracilis*.—C. L. **Withycombe**: On the function of the bladders in *Utricularia vulgaris* Linn. The bladders are not passive traps, but capture prey by active movement in response to stimuli. The valve is a continuation of the wall; it is two cells in thickness, and closes the mouth completely when its free margin is applied to the collar. It consists of three ill-defined regions; marking the third or marginal flap are four tapering bicellular hairs which are sensory. The quadrifid hairs lining the bladder constantly absorb the fluid within, until equilibrium is reached between the internal negative pressure and the osmotic tension which can be exerted by the cell contents of the hairs. There is now a considerable tension upon the valve, tending to pull it inwards. This is prevented by a cushion of specialised cells within the collar. Only an upward movement can possibly release the valve from its catch, and this is brought about by touching ·he sensory hairs.

Eugenics Education Society, December 14.—Prof. E. W. MacBride in the chair.—A. S. **Parkes**: Some aspects of reproduction considered in relation to eugenics. Inherent constitution is of prime importance from a eugenical point of view, but the conditions under which reproduction takes place may have the effect of limiting or augmenting the development of the hereditary qualities. If reproduction takes place under bad conditions, the fullest expression of the inherited characteristics will be hindered. Conditions obtaining during the maturation of the germ cells and during the gestation of the fœtus constitute the most potent of environments. The age of the mother is probably one of the most important factors governing the efficiency of the secondary sexual organs of the female for reproduction, and this is especially true of first births. The optimum age for reproduction seems, in the female, to be between twenty and thirty years, and first pregnancies occurring much after this age are attended by great probabilities of mishap.

CAMBRIDGE.

Philosophical Society, November 12.—Mr. C. T. Heycock, president, in the chair.—P. **Lake**: Wegener's theory of continental drift.

November 26.—Mr. C. T. Heycock, president, in the chair.—J. **Barcroft** and H. **Barcroft**: The hæmoglobin of Arenicola. The α band of oxy-hæmoglobin in Arenicola is 18 Ångström units nearer the blue than in human blood, and the α band in carboxy-hæmoglobin 12 Ångström units nearer the blue than in man. The pigment in Arenicola has a greater affinity both for oxygen and carbon monoxide than in the mammalia. The oxygen capacity in Arenicola is approximately 0·01 c.c. of oxygen per hour, an amount which is of the same order as that necessary to maintain the respiration of the worm whilst its hole is closed at low water.—C. **Shearer**: Direct measurements of axial gradients in embryonic tissue.—J. B. S. **Haldane**: A mathematical theory of natural and artificial selection. Pt. I. The effect of selection on the composition of Mendelian populations in certain simple cases is investigated by means of finite difference equations. Selection produces little change in the population when the recessives are few in number, except in the cases of inbreeding, assortative mating, and sex-linked inheritance.—H. Munro **Fox**: (1) The spawning of echinoids. The extrusion of the genital products of echinoids is due to the contraction of muscle fibres in the gonad walls. The contraction of these muscles can be artificially stimulated and spawning thus induced. A spawning male stimulates ripe individuals of both sexes which are in the neighbourhood to spawn. After spawning, *Strongylocentrotus lividus* re-forms ripe eggs in nine days at a temperature of 17°-19°. (2) The migration of a Red Sea crab through the Suez Canal. *Neptunus pelagicus* commenced to migrate through the Suez Canal in 1893, twenty-four years after the canal was opened, and reached Port Said in 1898. The crab has now spread along the Mediterranean coasts to Alexandria and to Haifa.—N. J. G. **Smith**: The parasitism of *Helminthosporium gramineum* Rab [leaf-stripe disease of barley]. This fungus produces leaf-stripe disease without being present in the growing-point, and it causes death if that point is reached. The fungus penetrates each young leaf (and finally the chaffs of the developing ear) from the enveloping sheath, the first sheath being infected from conidia, mycelium, or perithecia borne on the seed or elsewhere.—R. N. **Salaman**: A leaf index as a help to the identification of potato varieties. The first lateral leaflet on the left of the midrib of each leaf is measured, and its index $\frac{\text{breadth}}{\text{length}} \times 100$ calculated. The leaf index of a variety must be ascertained from adult leaves on a healthy plant. The variation of the index within any given variety is a normal one and represented by a normal frequency curve. The probable error of the difference of two means of 20 each is 0·7. A difference of two units in the index may be considered as of significance. Of 65 varieties of which the index was measured, the value of the latter varies between 50 and 72. Neither the place of origin of seed tubers, nor the locality where the plants are raised, has any effect on the leaf index, provided that the plants are healthy. The leaf index is a constant for each variety.

DUBLIN.

Royal Dublin Society, November 27.—Prof. E. A. Werner in the chair.—F. W. R. **Brambell** and J. B. **Gatenby**: On the supposed homology of the Golgi elements of the mammalian nerve cell, and the nebenkern batonettes of the genital cells of invertebrates. The Golgi apparatus in the smallest neurones of Helix is in the perinuclear extra-centric position, surrounding an archoplasmic sphere. In larger neurones it becomes dispersed around the nucleus and the individual elements become much more numerous. Basophil granules, probably representing the tigroid body, and also lecithin (?) granules, are described in the neurones. In silver preparations dark zones are found around the Golgi elements. These probably represent a product of its activity. Long and sometimes branched Holmgren canals were found in the neurones. They were separate and distinct from the Golgi elements. They may be processes of the subcapsular cells. From the position occupied by the apparatus in nerve and germ-cell, from its similarity of micro-chemical reaction in both, and from embryological evidence, it is believed that the nebenkern batonettes of the invertebrate germ-cells are homologous to the Golgi network of the mammalian neurone.

—H. H. **Dixon** and N. G. **Ball**: On the extraction of sap from living leaves by means of compressed air. Branches of *Tilia americana* and *Sambucus nigra* were enclosed in a strong cylinder in such a way that their cut ends protruded. Compressed air at pressures up to 20 atmospheres was admitted into the cylinder, and the liquid which exuded from the cut end of the branch was collected. This liquid was found to be completely, or almost completely, free from sugars. Experiments carried out in early and late summer gave similar results. After the leaf cells had been made permeable by means of toluene vapour the sugar in the expressed sap amounted to about 5 per cent.—H. H. **Poole**: Some experiments on the convection of heat in vertical water columns. Experiments are described on the convection of heat in single and also in double vertical water columns. In most cases, the flow of heat increases much more rapidly than the temperature gradient. The smaller the column the more rapid is the rise of heat flow with rise of gradient. It is concluded that, for the small gradient existing in the earth the effect of convection in water-logged porous rocks would be negligible. Where, however, water-filled fissures occur, we should expect an appreciable increase in the vertical flow of heat.

Royal Irish Academy, December 10.—Prof. Sydney Young, president, in the chair.—J. B. **Gatenby**: Notes on the human ovary, with special reference to the corpus luteum of ovulation. The minute cytology of the lutein cells of the human corpus luteum is described. There is a Golgi apparatus larger than the nucleus; the lutein granules are not true fat, but are probably the mitochondria loaded with lipochrome. A new type of cell is described, called the stellate chromophil cell, probably the homologues of the clasmatocytes of areolar connective tissue. Possible cytological criteria for distinguishing between the corpus luteum spurium and verum are given.

EDINBURGH.

Royal Society, December 3.—James **Chumley**: Deep-sea deposits of the Atlantic Ocean. This detailed research was based on a large series of deposit-samples (1426 in number) collected from the floor of the Atlantic by thirty-five expeditions between 1857 and 1911, varying in latitude from 50° S. to 60° N., and in depth from 110 to more than 4500 fathoms. The examination of these materials was in progress at the *Challenger* Office, Edinburgh, under the superintendence of the late Sir John Murray at the time of his death in 1914. Mr. Chumley, who was associated with Sir John Murray for a number of years as assistant, has finished the descriptions and worked up the results in accordance with the methods established by him. There are detailed descriptions of 1426 samples, which cannot fail to be of signal service in any future oceanographical work in the Atlantic. The descriptions are followed by a discussion of the information furnished as regards (1) the various types of deposits, (2) the distribution of the different constituents entering into the composition of the deposit.

MANCHESTER.

Literary and Philosophical Society, December 4.—W. B. **Wright**: The search for concealed coalfields in the north of Ireland. Valuable areas of unworked coal exist beneath the cover of the newer rocks in the counties of Antrim and Tyrone. The structure of the area covered by the newer rocks is controlled by a series of direct and transverse troughs at the intersection of which the deepest basins occur. As there is a considerable amount of evidence indicating that these basins are more accentuated in the older rocks below than in the overlying cover, they are very likely to contain the coal measures, which form the upper member of the older series. The margin of one of the coalfields so indicated is in fact visible at Coalisland, Co. Tyrone, where the newer rocks have been removed by denudation, and this is now being worked by Sir Samuel Kelly some little distance in from the outcrop. An exceptionally rich series of coals have been penetrated and a large output is confidently predicted.

SHEFFIELD.

Society of Glass Technology, November 21.—H. S. **Houldsworth**: Note on the influence of rapid chilling on the reversible expansion of clay. The phenomena cited are consistent with the explanation that solution of free silica occurs at the higher temperatures of heating, that this separates out as cristobalite or tridymite on slow cooling. It does not so separate on rapid cooling. Some imperfect separation is likely, but not in a sufficiently definite form to be able to exert its proper influence on the expansion phenomena.—P. **Marson**: Glasshouse pots: some notes on their manufacture and use. The mixing, weathering, and preparation of the clays were described. Pots which have been stored for a long period after drying give more trustworthy results than new pots used shortly after drying. Of faults which develop in the drying room the chief are cracks across the bottoms of the pots and drying cracks along the angles inside. Nine days should be occupied in heating up large pots in the pot arch. After setting, the pot should be left to mature in the furnace for not less than 48 hours before filling on.—Kurd **Endell**: The casting process for glasshouse refractories in German glass plants. Tests show that cast pots are denser than hand-made ones. Cast pots are chemically more resistant than hand-made pots, and there is no perceptible difference between them in respect of heat resistance.

CALCUTTA.

Asiatic Society of Bengal, November 7.—N. **Annandale**: Aquatic gastropods. (Zoological results of the Percy Sladen Trust Expedition to Yunnan in 1922.) The most remarkable feature of the water-snails of the province of Yunnan, particularly those of the great lake Erh-hai, is the close resemblance between many of the shells and those of certain tertiary beds in Central Europe. Definite relations exist between these shells and those of the tertiary beds of the Shan plateau, but the resemblance between the Chinese and the European species is due to the convergent evolution.—W. M. **Tattersall**: Crustacea Amphipoda. (Zoological results of the Percy Sladen Trust Expedition to Yunnan in 1922.) Two specimens of Gammarus were collected, *G. annandelei* recently described from eastern China and Japan, and a new species allied to *G. crassus* from the Caspian Sea.—R. B. **Seymour Sewell**: Geographic and oceanographic research in Indian waters. (1) The geography of the Andaman Sea basin. The basin bounded by the Nicobar-Andaman ridge and the ridge itself are of composite character. A barrier-reef of coral exists on the western side of the ridge. (2) A study of the nature of the sea-bed and of the deep-sea deposits of the Andaman Sea and the Bay of Bengal. Charts are given showing the nature of the deposits at different points, the limits of the deposits of mud brought down by the great rivers, and the influence of currents on the bottom. (3) The density and salinity of the waters of Indian seas.

(*a*) The South Burma coast and Mergui Archipelago. The distribution and oscillation of salinities and densities off the coast of Burma at different seasons and times of day and the influence of air temperature, winds and other factors on the density of the surface water are discussed.—Sat Kori **Dutta**: On a peculiar disposition of the liver and the kidney in the genera Clarias and Saccobranchus. R. C. **Majumdar**: The date of the Khaḍga dynasty of Bengal. Hitherto the date has been unanimously read as year 13. The numerical figures should be read as 79 or 73. Referring this year, 79 or 73, to the Harsha era, a date is obtained for the Khaḍga Kings in the 7th century A.D., and this date is corroborated by some Chinese accounts of the political conditions of Samataṭa towards the close of the 7th century A.D.

CAPE TOWN.

Royal Society of South Africa, September 26.—Dr. A. Ogg, president, in the chair.—J. D. F. **Gilchrist**: On a protozoal parasite of the snoek, *Chloromyxum thyrsites*, sp. n. The Cape "snoek" and the Australian "barracouta" (*Thyrsites atun*) show a softening or liquefaction of the muscular tissue, caused by a protozoal parasite resembling Chloromyxum. The spore is quadriradiate, about 12×8 microns, has four polar capsules, and only four distinct nuclei were seen. The trophozoite is unicellular increasing by schizogeny or simple fission, and is usually intercellular. Each trophozoite produces a single spore.—B. F. J. **Schönland**: Note on cathode ray absorption. The theory of absorption due to Bohr is in good quantitative agreement with new measurements of the absorption of cathode rays by matter. In applying the theory to measurements of the decrease of velocity of rays in passing through matter, Bohr has deduced the relation $(V_0 - V)V_0^3 = ct$, where V_0 = initial velocity, V = final velocity, t = thickness, c = constant. Existing measurements have all been put in the form $V_0^4 - V^4 = Kt \ldots\ldots (2)$. This last equation reduces to Bohr's form in the case where V and V_0 are nearly equal. The value of c for aluminium deduced from Terrill's observations is $4 \cdot 0 \times 10^{42}$, while that calculated from Bohr's theory is $4 \cdot 1 \times 10^{42}$.—Joseph **Kürschák**: On matrices connected with Sylvester's dialytic eliminant.

SYDNEY.

Linnean Society of New South Wales, September 26.—Mr. J. J. Fletcher, vice-president, in the chair.—A. J. **Turner**: A revision of the Australian Anerastrianæ (Lepidoptera). Only five Australian genera, which can be easily tabulated, namely, Statina, Calamotropa, Emmalocera, Anerastria, and Saluria, are recognised. Four species are described as new.—C. T. **White**: A new conifer from Southern Queensland. Description of a new species of Callitris, close to *C. calcarata* R.Br. but easily distinguished by the characters of the cones.—R. **Greig-Smith**: The high temperature organism of fermenting tan-bark. Pt. iii. The organism produces carbon dioxide from a number of carbon compounds. These include carbohydrates such as saccharose, dextrose, levulose, maltose, lactose, galactose, xylose, dextrin, starch, gum acacia; alcohols such as mannit, glycerin, amyl, and ethyl alcohols; salts of organic acids such as citric, lactic, succinic, acetic; nitrogenous substances such as peptone, asparagin, meat-extract. Ammonium salts and urea can serve as sources of nitrogen. Raffinose and inulin are scarcely fermented. Oxalates and formates are not attacked.—T. **Steel**: On some abnormal sugar-canes. A series of abnormal sugar-canes grown in Australia is figured and described, comprising examples of forking, multiple and suppressed budding, peculiar joints and regularly malformed joints. It has been observed in Australia that while striped canes grown from "sets" reproduce the characters of the parent cane, seedlings from similar canes are always plain without stripes. This may indicate reversion to an original stripeless cane. Wild native cane in Fiji is always either red or yellow but has no stripes.—A. M. **Lea**: On some Australian Galerucides. These are small but destructive leaf- and flower-eating beetles. Ninety-three species of the genera Monolepta and Candezea are described as new.

Royal Society of New South Wales, October 3.—Mr. R. H. Cambage, president, in the chair.—M. B. **Welch**: (1) The secretory epidermal cells of certain Eucalypts and Angophoras. The elastic covering of rubber found on the young leaves of many of the Eucalypts and the closely allied genus, the Angophoras, is secreted by the outer or epidermal cells, which are of a peculiar shape. This covering acts as a very efficient means of reducing evaporation from the leaf; and the fact that only the more primitive species possess it, seems to indicate that originally the Eucalypts were exposed to much greater extremes of temperature than at present. (2) Note on the effect of temperature on borers attacking seasoned and unseasoned timber. Owing to the difficulty experienced in getting any liquid to penetrate more than a fraction of an inch into sound timber by ordinary methods of application (with the exception of certain of the softer pines and brush timbers), it is not easy to rid infested timber satisfactorily of the borer pest. Where timber is badly attacked there is far greater opportunity for any deterrent liquid to penetrate. A method of eradication which has been tried successfully is the application of heat. A temperature of about 113° F. for one minute in moist air is usually sufficient to kill the borer.—W. L. **Waterhouse**: Note on the occurrence of double embryos in wheat grains. Amongst germinating wheat grains of the varieties Tandilla King and Federation, two grains were found, each having two embryos. Each gave rise to two shoots and six seminal roots. The seedlings are growing, and further studies are projected if grain is produced.

Official Publications Received.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Montserrat, 1921-22. Pp. iv+28. (Barbados.) 6*d*.

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1923. Pp. 26. (Bristol.)

Industrial Federation of University Women. Bulletin No. 5: Report for the Year 1922-23. Pp. 75. (London: 92 Victoria Street, S.W.1.)

The University of Manchester: The Manchester Museum. Report of the Museum Committee for the Year 1922-23. (Museum Publication 86.) Pp. 19. (Manchester: University Press; London: Longmans, Green and Co.) 6*d*.

The Hundred and First Report of the Commissioners of His Majesty's Woods, Forests, and Land Revenues. Pp. 43. (London: H.M. Stationery Office.) 4*s*. 6*d*. net.

London School of Tropical Medicine: Department of Helminthology. Collected Papers, 1923. (Part 4.) Nos. 36-49. (Reprinted from various scientific periodicals.) (London: 23 Endsleigh Gardens, N.W.1.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 506: Surface Water Supply of the United States, 1919–1920. Part 6: Missouri River Basin. Pp. 411+2 plates. 35 cents. Water-Supply Paper 515: Surface Water Supply of Hawaii, July 1, 1918, to June 30, 1919. Pp. iv+123. 15 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 748: The Twentymile Park District of the Yampa Coal Field, Routt County, Colorado. By Marius R. Campbell. Pp. iv+82+13 plates. (Washington: Government Printing Office.) 20 cents.

Smithsonian Institution: United States National Museum. Bulletin 104: The Foraminifera of the Atlantic Ocean. By Joseph Augustine Cushman. Part 4: Lagenidae. Pp. x+228+42 plates. (Washington: Government Printing Office.)

SATURDAY, DECEMBER 29, 1923.

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Government Publications and their Distribution.

WHEN a government takes in its own hands the publication of matters of scientific interest, it may be assumed that this is done with three distinct objects in view. In the first place, it wishes to bring to the notice of scientific workers the results of original researches carried out by experts in Departments under its control, in order that these results may form a foundation for further advance in knowledge. So are published the papers comprised in the excellent scientific reports of the Ministry of Agriculture and Fisheries in England, and of the Fishery Board for Scotland. Or it desires to bring to the notice of the public, for the sake of the individual and through him of the nation at large, the condensed wisdom of science as bearing upon matters of practical importance. Such is embodied in the pamphlets and leaflets dealing with agricultural pests and plant diseases, with methods of land-cultivation and stock-raising, issued by the Ministry of Agriculture and Fisheries and the Board of Agriculture for Scotland. Sometimes these two aims are seen to run side by side, as in the Journals of Agriculture published both by the English Ministry and Scottish Board, in which matters of both scientific and practical interest appear.

The third object is very different from either of the above, its end being to inform the outside world, scientific and non-scientific, regarding the activities of institutions in which a general interest is taken ; it takes its typical form in the annual reports of such establishments as the British Museum, the Natural History Museum, and the Royal Scottish Museum. This last object may seem to have little of scientific value to commend it, but it is in reality of prime importance; for institutions of the kind mentioned depend for many of their most valuable acquisitions upon the generosity of the public, and unless public interest is stimulated by full knowledge of progress and requirements, the national collections, and science, must in the end suffer.

The duty of scientific publisher assumed by the Government does not end, however, with the printing of pamphlets, nor are its aims thus attained ; the question of distribution is second only to that of printing, and it is to this that we wish particularly to direct attention. Every scientific worker is aware of the generous and even lavish free distribution of scientific publications carried out by Government Departments of the United States of America ; and one is tempted to speculate whether the activity and originality of research now apparent there may not be due in part to this sustained appeal to the scientific mind.

At no time could H.M. Government have been charged with a lavish or even generous distribution of the scientific fruits its workers have culled. It now appears that even the meagre distribution of former years is to be curtailed, and a false notion of economy threatens practically to abolish the free circulation of government publications of scientific interest. The new policy affects the three types of publications already mentioned in various ways.

In recent years, the annual reports of the Museums have dwindled until they have become dry skeletons, scarcely worthy of distribution, and quite unworthy of the great national institutions they represent. Compare them with the beautifully printed and illustrated reports of the American State Museums. Surely this is not the way to encourage the free giving of the public, on which the American Museums and our own so largely depend.

The leaflets of the English and Scottish Departments of Agriculture were formerly sent gratis on publication, from a standing list, to gardeners, farmers, and others interested in the checkmating of pests or the improvement of cultivation, and the wide distribution of these concise and generally up-to-date publications played a great part in combating local pests, and possibly in preventing the local pest from becoming a national pestilence. Now, to be received free each leaflet must be applied for in writing, and only one copy of any one leaflet is supplied gratis: the free circulation as a matter of routine has ceased.

As regards research publications, the position is no less serious. Here also free distribution to workers interested in like fields has ceased, and scientific societies no longer receive copies in exchange for their own publications. Yet, curiously enough, the scientific worker in foreign countries is to be given a preference denied to his British colleague, for foreign societies making exchanges are not to be placed under the ban.

A still further restriction has been brought into force. The circulation of the records of scientific discovery has always been greatly aided through the strictly discriminate distribution, by the discoverer himself, of author's separates; and most scientific journals are still willing to present an author with twenty-five copies or so of an original contribution. But personal application to government scientific workers for a particular separate has disclosed the fact that, at any rate in certain important scientific departments, the allowance of author's reprints granted by Government is limited to *three* copies, though indeed if the published price of the pamphlet be less than one shilling he may have six. A joint author, provided he has contributed more than a third of the research, is entitled to one-third of this normal allowance. Could cheese-paring be more ridiculous?

It would seem that, in the desire to save a mite, the Government is in danger of losing a mountain. The cost of a relatively small number of off-prints, once the type has been set up, can scarcely be compared with the gain likely to accrue from a wide circulation of scientific matter of practical and economic importance; and in this respect the Government has duties to the public and the scientific world other than those of a publisher controlling a purely commercial undertaking. As the matter stands, government researches will continue to be made, and the results laboriously gained by trained and expert workers will be printed at very considerable cost—and then consigned to oblivion in the cold storage chambers of H.M. Stationery Office or some other department.

There is no suggestion here that the Government should undertake wasteful distribution. It has always seemed to us unnecessary that when an allotment-holder applied for agricultural leaflets, having in mind garden pests, he should receive also instruction in pig- and poultry-keeping, in the values of farm manures, or in the financial affairs of agricultural co-operative societies. But this danger might be avoided by, let us say, grouping the leaflets for free distribution in distinctive and homogeneous sections for particular classes of inquirers, rather than by the drastic step of abandoning altogether the method of free routine distribution. Perhaps, short of the generous distribution of scientific papers with which the United States have made us familiar, something might be done by the wide circulation of the periodical H.M. Stationery Office lists of Government publications, from which scientific societies or interested individuals might select and apply for such works as concerned their own field of activity.

In any event, the distribution of Government publications dealing with matters of scientific interest cannot remain as it stands at present; it is based upon a narrow idea of the importance of the spread of scientific knowledge, even upon a mistaken computation of the pecuniary value of science. How diametrically opposed it is to the trend of enlightened opinion in Great Britain is indicated by a recent decision of the Carnegie United Kingdom Trustees to increase still further their free circulation of expensive books to whatsoever individuals care to take up any serious study. What is wanted is not less facilities for making scientific knowledge and achievement widely known, but more. It is to be hoped that scientific societies will not permit the recent restrictions to pass unchallenged, and will unite to secure for the public and for scientific workers the fullest publicity for information of service to them as stimulus or as guidance.

The Physiology of Sex-Determination.

The Mechanism and Physiology of Sex Determination. By Richard Goldschmidt. Translated by Prof. William J. Dakin. Pp. ix + 259. (London: Methuen and Co., Ltd., 1923.) 21s. net.

PROF. GOLDSCHMIDT gives us an object-lesson in the way in which a single problem, at the outset not apparently more important than a thousand others, may, if pursued to its limit, be made to yield results of the deepest importance and the widest application.

It has long been known to entomologists that crosses between different species, and often also races, of Lepidoptera frequently produce a number of sexually abnormal forms. This was the starting-point of the investigation which has finally enabled Goldschmidt to make his important contribution to the study of sex-determination, and indeed to the problems of differentiation in general.

Put in the briefest possible way, we may sum up the results of his twelve years of work upon the sexual abnormalities arising in racial crosses of the Gipsy moth (*Lymantria dispar*) as follows. In the first place, since moths have two active sex-(X-)chromosomes in the male, and one in the female, the male-determining factors are in double dose in males, single dose in females. The female-determining factor Goldschmidt has finally located in the Y chromosome—an interesting fact, since the work of the Morgan school on Drosophila has shown that there the Y chromosome is without influence upon sex-determination. He has next shown that the strength or "potency" of the sex-determining factors may vary, and does actually do so in the different sub-species and races employed. It follows that when a cross is made, the future distribution of the sex-factors of various strengths, both male- and female-determining, can be prophesied from what we know of the behaviour of the chromosomes, or, in other words, on Neo-Mendelian principles.

As to the mode of action of the female-determining factor, we have the important fact that the Y must exert its effect upon the growing oocyte, since we find that the female-determining factor (which is inherited purely maternally according to expectation) is effectively present in males as well as females, although, of course, in all eggs destined to give males the Y has been eliminated in the polar body. If we are to draw conclusions, it appears that some substance, which Goldschmidt considers as of enzymatic nature, is given off into the oocyte in quantity proportional to the "potency" of the female-determining factor in the Y, and exerts effects in embryonic development proportional to its quantity. It is clear that if this is fully substantiated, it gives us important clues as to the possible mode of action of chromosomal genes.

By these last facts we are introduced to the second part of the problem—the mode of action of the sex-factors during development in contradistinction to their distribution to the gametes and zygotes—a field where Goldschmidt has made his most signal contribution. What do we start with?—the presence in every male moth of two doses of male-determining, and one dose of female-determining substance; whereas in the female, to the same quantity of female-determiner there is only one dose of male-determiner. But, since normally, in spite of the presence in individuals of either sex of determiners for both sexes, we get only the two classes male and female, we must say that (using the symbols M and F for our two sex-determiners) $2M > F$, whereas $F > M$.

When different races were crossed, abnormalities were produced. Goldschmidt was, in the first place, able to demonstrate that, whatever the degree of abnormality (and all degrees are possible), they fell into two classes, those which started their development as females but ended it as males, and those which started it as males and ended it as females. They thus have no kinship with the other main type of sexual abnormality known in insects, in which one half (or some definite section) of the body is of one sex, the other of the other. These latter animals are thus sex-mosaics in space, whereas Goldschmidt's are sex-mosaics in time. The term *gynandromorphs* should be restricted to the spatial type, the term *intersex*, or better *consecutive intersex*, being used for the other. The origin of gynandromorphs is to be sought in an abnormality of mitosis whereby an X chromosome is lost from one embryonic nucleus, whereas that of the intersex is to be looked for in the faulty balance of sex-factors.

It is only in certain crosses that intersexuality appears. An analysis of the families, together with the above-mentioned discovery of the transformation of sex during development in the intersexes, led to the following far-reaching conclusions. Broadly speaking, most of the Japanese races of the species possess sex-factors of high potency, the European races of low potency. Intersexes result (1) when a high-potency or "strong" M (male-determiner) is combined with a "weak" F—in which case the result is a *female intersex*, or one which is genetically female and starts its development as a female, but is later switched over to maleness; or (2) when two weak M's are combined with a strong F, in which case *male intersexes* are found.

Further, within each main group, the separate races may differ in regard to the strength of their sex-factors;

and this will be reflected in the different *degrees* of intersexuality resulting from different crosses.

These facts, and various interesting consequences of the facts, may be regarded as firmly established. It should be noted that there are one or two local races which have given curious results, which will have to be worked out in greater detail.

Goldschmidt's further argument is as follows. The expressions "2M - F" and "F > M" express only the conditions in the fertilised eggs before development has started. The further facts can be explained only if we suppose that, during development, in each cell of the body sex-controlling substances are produced at definite rates, and that these rates are proportional to the original quantities of the sex-factors. When, for example, a strong M and a weak F are present together in an egg, not only is the difference F - M abnormally small, but the rate of increase of F or of substances produced by it is lower, that of M higher, than usual. As a result, the two curves eventually intersect; and, of course, from this moment the individual, hitherto female, is switched over to the male type of development, and a female intersex is the result. The degree of abnormality is of course determined by the relative rates of F- and M-production, and the consequent earlier or later incidence of the intersection-point in the life-history.

If the intersection-point comes early enough, and the change to the "wrong" sex occurs before any chitinisation has taken place, sex-reversal will be apparently complete, and we shall get nothing but one sex from our cross. This does occur.

Let us suppose the sex-reversal is from female to male. Then, in the resultant all-male broods, half the individuals should be genetically females, and therefore be of chromosome-constitution XY instead of XX. If mated with normal females, therefore, they should give an abnormal sex-ratio (2XY = ♀♀ : 1XX = ♂ : 1YY —dies), as was pointed out in general terms by Morgan and by the reviewer some time ago. Similar sex-reversal followed by abnormal sex-ratio in the next generation has since been shown to occur by two independent workers in the frog, and now Goldschmidt has rung the changes upon it in Lymantria and has shown that in every case the results fit with expectation. Thus the final *somatic sex* may be the opposite of the original *zygotic sex*.

But we can go even further than that. The reversal (total or partial) of the original sex may be due either to genetic or to other factors. In Goldschmidt's moths the reversal is due to genetic causes—the fertilised egg contained inevitably within itself the seeds of its eventual change of sex, in the form of a quantitative disharmony of the sex-determining factors.

But sex may be upset by outer agencies: by hormones, in the case of vertebrates, whether the experiment be of Nature's (as in the Free-martin, the female intersex of cattle, owing its abnormality to the male hormones of its own twin brother), or of man's (as in the remarkable castration and grafting experiments of Steinach, Sand, Moore, Lipschütz, Goodale, and others); by parasites, as in crabs and insects; or by interference with the gametes, as in the increased number of males produced in frogs (Hertwig and his pupils) or trout (Mrsic) by over-ripeness of the ova.

The earlier rigid belief that sex-determination was entirely a matter of the chromosome-constitution must therefore be modified. Sex, in all higher animals and in some plants, is *normally* determined by the chromosomes, but (as might have been foreseen) the normal agency can in certain circumstances be overridden.

It is clear that, with the point of view arising from these facts, much that is both new and important has been gained. In the first place, we have the confirmation of the idea, which had become established as a result of the work on Drosophila, especially by Bridges, that sex-determination was an affair of balance between genes contained in the sex-chromosomes and other genes.

Bridges, by the utilisation of triploid strains, showed that in the fly, while the female-determiner was mainly lodged in the X (since here the female is XX, the male XY), male-determination was not an affair of one but of several factors, a disproportionate amount of influence being entrusted to that or those in the diminutive 4th chromosome. Two X's in the presence of three sets of autosomes gave intersexes: if only two instead of three of the 4th chromosomes were present, the intersexes were of more female type. We do not profess to understand Goldschmidt's comments (p. 99):—". . . . instead of speaking of the different quantities of a sex factor he [Bridges] prefers to speak of a more or less greater number of factors. Logically as well as physiologically this is naturally the same."

Although Goldschmidt has shown that his "F" substance is largely due to factors lodged in the Y chromosome, yet it may be confidently predicted that numerous "sex-modifiers" will be discovered in the autosomes.

Our second principle is concerned with development. Goldschmidt's idea of different rates of production of substances in the embryo is in itself very fruitful, while if his correlation of the rate of production of the substance with the amount of some initial ferment contained in the gene, and this amount with the "potency" of an allelomorph in a multiple series,—if this is substantiated, we acquire a new outlook into the relation between Mendelian genes and their mode of action in development.

That a correlation of some sort does exist between rate of developmental processes and nature of gene appears to be established; but whether there exists the exact chain of events imagined by Goldschmidt is a matter for further verification.

How valuable is the conception of rate of production of substances in ontogeny is seen by the rapid application which it has found in other fields. Crew has applied this idea to the explanation of various puzzling abnormalities of the reproductive organs to be found in mammals, and by so doing has removed them from the lumber-room where they lay labelled with the meaningless title of "pseudo-hermaphroditism" to a place in a coherent biological scheme. It appears more than probable that the determining factor in Amphibian metamorphosis, with all its curious variations from species to species, is simply the relative rate of thyroid growth. It will assuredly prove that the same concept will be of prime importance as regards the other endocrine glands in all their functions of growth-regulation and of initiating new phases such as puberty. In brief, the ideas of physical chemistry are thus being introduced into embryology, and dynamic ways of thinking substituted for static.

So much for the important positive results, both of fact and theory, which flow from Goldschmidt's work. It remains to criticise some of his details.

We think it right in the first place to emphasise the fact that the well-known curves illustrating the physiology of intersex production (p. 95) are quite hypothetical in their details—a fact not sufficiently brought out in the text. They could be drawn in a considerable number of quite other ways and still satisfy the facts. In particular, this applies to the representation of the curve for production of "female" substance as rising to a maximum and then sinking again. This is of great theoretical importance if really true; but no adequate discussion is given of the reasons for the adoption of this particular curve, nor for the rejection of, *e.g.*, a curve which continued to rise throughout life.

The same, *mutatis mutandis*, is true of various other of the curves presented later for other organisms—although here their hypothetical nature is made clearer. We think that in many cases it would have been equally easy to employ the idea of alteration in susceptibility of tissues to a constant stimulus (as exemplified, *e.g.* in the alteration in susceptibility of Anuran limbs to thyroid at metamorphosis) instead of that of alteration in the amount of morphogenetic substance (intensity of stimulus).

We note the absence of reference to Haldane's interesting work (in reality a corollary of Goldschmidt's own principles) that when one sex is reduced in numbers or abnormal in structure as a result of a varietal or specific cross, it is—not always the male or always the female, but—always the heterogametic; and also wonder why play is not made (pp. 222-224) with the idea that sex-linked semi-lethal factors account for the well-known differential elimination of males before and soon after birth in man and other mammals—an idea which at least gives full formal explanation of otherwise incomprehensible facts.

In his discussion of human sexual abnormalities (p. 243) the author has only been thinking in terms of his previous Lymantria scheme, which will give greater or lesser sex-transformation as a result of faulty balance of sex-genes: Crew's recent papers on goat and pig intersexuality suggest another and simpler explanation, in the idea of abnormally slow production of the male hormone, but without any switch-over from one sex to the other. No reference is made to the classical work of Pézard on birds, in which the effect of the gonad hormones upon growth-rate of sexual characters is so ably analysed.

These, however, are matters of comparatively minor moment. The main thesis of the book stands, and is of great value. In addition, various subsidiary topics are discussed with great lucidity. We especially commend the section on secondary sexual characters. The treatment is not new, but so clear and incisive that after reading it there should be no excuse for the not uncommon misconception that the inheritance of such characters throws any light upon or is in any way correlated with the inheritance of sex itself, save only that once sex is determined, it controls the *expression* of one or the other set of secondary characters.

The well-known difference between the physiology of sex-determination in insects and vertebrates—in the former independent of all gonadial influence, in the latter put under this influence from a very early period of ontogeny—the author correlates with the general shortness of life in insects as against its greater length in the higher group. This is an extremely suggestive idea; it will be interesting to see whether subsequent research upon the connexion of gonad and sexual characters in other invertebrates will bear it out. Finally, after the mass of nonsense and vague theorising that has been written on the sex-ratio, we commend his chapter on the subject as an admirable tonic.

It has seemed worth while to go into some detail regarding the thesis and scope of the book, in spite of its having been first published in German three years ago, since here for the first time are English readers provided with a translation (which, since Goldschmidt has incorporated recent work, is also a second edition). The book is intended for medical men and others, such as lawyers or sociologists, who may have occasion to study the problems of sex, as well as for the professional

biologist, and it is a fact, however unfortunate, that the great majority will not read a foreign language unless they must. The translation is direct and adequate, and reads smoothly, although a few Germanisms might be got rid of in a second edition.

Work on the problems of sex is proceeding so rapidly that Doncaster's and Morgan's books on the subject, although not ten years old, are quite out-of-date. We have no hesitation in recommending Goldschmidt's work as the best existing introduction to the subject, and tendering our thanks to Prof. Dakin for his translation. JULIAN S. HUXLEY.

Chemistry of Urea and Resins.

(1) *The Chemistry of Urea: The Theory of its Constitution, and of the Origin and Mode of its Formation in Living Organisms.* By Prof. Emil A. Werner. (Monographs on Biochemistry.) Pp. xii+212. (London: Longmans, Green and Co., 1923.) 14s. net.

(2) *Synthetic Resins and their Plastics.* By Carelton Ellis. Pp. 514. (New York: The Chemical Catalog Co. Inc., 1923.) 6 dollars.

(1) THE monograph on urea differs somewhat in scope from others of this series of which it forms a part, inasmuch as it deals almost exclusively with one compound. Its importance, however, in animal and vegetable life is unquestioned, and no one will feel that a whole volume devoted to this topic is an unnecessary addition to biochemical literature. The subject-matter is divided into two sections: the first treats of the synthesis and constitution of urea; the second with its origin and occurrence in Nature.

There is no one more competent to write on urea than the author, who for many years past has attempted to unravel its structure. A considerable portion of the first section is concerned with this problem, and it must be confessed that Prof. Werner has made out a strong case for the tautomeric formula

$$\mathrm{HN:C}\begin{cases}\mathrm{NH_2}\\ \mathrm{OH}\end{cases} \rightleftarrows \mathrm{HN:C}\begin{cases}\mathrm{NH_3}\\ |\\ \mathrm{O}\end{cases}$$

There is no doubt that the majority of changes which urea undergoes with different reagents and by heating, such as the formation of biuret, and the conversion of ammonium cyanate into urea, which is represented thus:

$$\mathrm{H_4N.O.CN} \leftrightarrows \begin{matrix}\mathrm{NH_3}\\ +\\ \mathrm{H.O.CN}\end{matrix} \rightleftarrows \mathrm{HN:C:O} \rightleftarrows \mathrm{HN:C}\begin{cases}\mathrm{NH_3}\\ |\\ \mathrm{O}\end{cases}$$

may be equally well explained by the new formula. Moreover, the formation of cyanuric acid and the action of alkalis receive a much simpler interpretation in this way.

(2) As a rule, an organic chemist, when confronted in the course of an investigation with a resinous product, is discouraged from examining it further. It is an amorphous, intractable material which generally defies crystallisation and, consequently, the only satisfactory means of purification. It is therefore consigned to the scrap heap. The technical chemist, on the other hand, whose business it is to manufacture varnishes and composite materials, such as printing-inks, paper and cloth size, linoleum, etc., far from despising such products, is able to utilise many so-called synthetic resins on a very considerable scale. The volume under review gives a very comprehensive account not only of the production and use of synthetic resins; but also a detailed description of the machinery used in their application. He tells us that "the diminishing supply of natural resins, or *gums*, as the trade prefers to call them, has been viewed with apprehension during past years by varnish manufacturers and other large consumers of such products."

It appears that the introduction of phenol-formaldehyde and cumarone resins has opened up a new field for the synthetic organic chemist. There is a remarkable variety of substances now employed and derived from such products as glycerin and phthalic acid, vinyl polymerisation products, urea and thiourea derivatives and sulphur phenol resins. The author advises the chemist to scrutinise carefully every new resin he may obtain and record its formation. Here is a new and interesting field of operations, and instead of feeling thwarted in his aim, the organic chemist may in future turn what he formerly regarded as a failure into a possibly lucrative success. J. B. C.

Micrography as a Fine Art.

Botanical Pen-Portraits. By Prof. J. W. Moll and Dr H. H. Janssonius. Pp. viii+472. (The Hague: Martinus Nijhoff, 1923.) 30 guilders.

IT was not until about the middle of the nineteenth century that descriptions of microscopical characters were introduced into treatises concerned with the identification of drugs. There are now several books primarily designed for students of pharmacy, but occasionally referred to by botanists who endeavour to demonstrate to their students that even a knowledge of plant histology may have its economic value. The volume by Prof. Moll and his junior collaborator aims at giving greater precision to the description of vegetable drugs and therefore greater accuracy in their identification.

Prof. Moll has devoted himself during the last twenty

years to a subject which demands no little concentration of effort and an enthusiasm that is proof against the dullness of tedious routine; he has devised a method of scientific description which he believes to be an advance upon all previous systems. The technical value of this method can only be thoroughly tested by specialists, but a mere botanist can at least appreciate the soundness of the underlying principles and the meticulous attention to details. The author is to be congratulated on the successful completion of a labour of love which is a contribution of great value to the pharmacologist and to all botanists whose aim is to acquire an orderly and thoroughly sound method of describing plant structures.

An adequate description of a plant must take account not only of the characters in which it differs from allied types, but also of those which it shares with other plants. Pen-portraits aim at furnishing a summation of characters, the replacement of sketches of habit by clear descriptions based on a definite scheme which is given in full and constitutes a very important feature of the book. They do not rely upon detailed anatomical drawings to supplement imperfect descriptions: a pen-portrait, if thoroughly made, is self-sufficient and at most needs only a well-labelled diagrammatic representation of the plant organ under consideration; it brings into the description "as much as possible of what is now generally considered as belonging to the domain of drawings and plastic models, in other words, it tends to make pictures more and more superfluous." The diagrammatic illustrations are exceedingly clear, and of a kind which might with advantage be adopted as a model by authors of botanical text-books.

The value of Prof. Moll's method was demonstrated by the junior author, Dr. Janssonius, in his book, published in 1906, on the micrography of Javan trees: an extension of the same method to timber trees of other regions would be a great boon to botanists, especially to such as are interested in the identification of fossil angiospermous woods.

The preface, which is much more than a preface in the ordinary sense, gives a clear account of the history of descriptive botany, with special reference to microscopical features, and emphasises the importance of a more definite employment of the Linnean method in micrography. Prof. Moll considers that the principal feature of the Linnean method is its conformity to a sequence fixed beforehand; if it is rigorously followed, completeness is achieved and nothing is omitted by chance. A high standard is set, and the "guiding schemes," if the student has sufficient faith and patience to adopt them, supply the means of constructing pen-portraits according to the admirable patterns contained in this great work. Most of the volume is devoted to descriptions of drugs arranged in alphabetical order—Amylum, Cortex, Flores, Folia, Fructus, etc.—and a full bibliography is added. In illustration of the method, the headings of the section dealing with Cortex Cinnamomi may be given: macroscopic characters; anatomical characters, followed by a list of references; epidermis, including measurements of cells; cortex, cork, phellogen, phelloderm; primary cortex; endodermis; stele, including detailed description and cell-contents of the tissues; micrography of the powder, bast fibres and other cells, crystals, starch grains, etc. A word of praise is due to the publishers for the printing and style of the book, and to the authors for their decision to present their work in well-written English. A. C. Seward.

Our Bookshelf.

Text-book of Agricultural Bacteriology. By Dr. F. Löhnis and Prof. E. B. Fred. (Agricultural and Biological Publications.) Pp. ix + 283 + 10 plates. (New York and London: McGraw-Hill Book Co. Inc., 1923.) 15*s.*

Dr. Löhnis' "Vorlesung über landwirtschaftlicher Bakteriologie" has for so long been regarded as an essential text-book, that students of agricultural bacteriology will especially welcome the excellent English edition of this work which the author has produced in collaboration with Prof. E. B. Fred.

The authors devote the first portion of their work to a description of the characteristics and general activities of micro-organisms. This part of the book contains useful chapters in which the general methods used in studying the organisms are discussed. The second half of the book is devoted to the special fields of bacteriology that touch upon the problems of agricultural research and practice. There are chapters on the bacteriology of silage, hay, and other food materials, on milk, butter, and cheese, on the methods of sewage disposal, on the changes involved in the making of farmyard manure and on the problems of soil biology. In these chapters the authors deal with their subjects with remarkable clearness. The very different problems that arise in these fields of work make it very difficult to connect them as though they formed a single branch of applied science. It seems that the sequence of thought would have been better preserved in this portion of the book if the bacteriology of soil had been considered before that of dairy products, because, in the former subject, the problems involved so completely cover the field of microbiology, that the authors have already been obliged to refer to the chief groups of soil bacteria to illustrate the activities of bacteria in general. In dealing with the bacteriology of soil and of dairy products, the authors discuss some of the special methods used in these fields of work. In a later edition, the description of special methods might well be given in greater detail. At present, lack of standardisation in technique greatly hinders work with bacteria, and this is especially the case with soil and dairy bacteriology. A detailed description of the best

methods, given in such a well-known text-book, would greatly assist the adoption of a uniform technique.

In the portion of the book devoted to soil bacteria, the activities of protozoa and other micro-organisms are mentioned, but greater emphasis should have been given to the close interrelation that exists between bacteria and other organisms in the soil. The close connexion found to exist in field soil between the rapidly changing numbers of bacteria and active amœbæ illustrates the fact that the bacteria must be considered as a part of the complex population of the soil. H. G. THORNTON.

Mine Examination Questions and Answers. Compiled from Examinations for Positions of Mine Inspector, Mine Foreman, Assistant Foreman, Fireboss, Hoisting Engineer, Safety Inspector and Shotfirer. By Prof. J. T. Beard. Part 1. Pp. viii + 258. Part 2. Pp. vi + 259–546. Part 3. Pp. vi + 547–872. (New York and London: McGraw-Hill Book Co. Inc., 1923.) 3 parts, 37*s.* 6*d.*

THE object of the work under notice is, as stated by the author in his preface, that of "enabling candidates to pass successful examinations for positions of responsibility in coal mining," and it consists of a set of answers to no less than 2975 questions, set in examinations in the various coal-mining states of the United States of America and in Canada for various grades of colliery officials. Opinions will certainly differ as to whether this is the best way of qualifying a man for the duties that he will have to perform after he has passed such examination; it may readily be granted that a man, gifted with an exceptional memory, might get off by rote the whole of the answers to the questions given in these three volumes and would thus with ordinary luck pass successfully any of the examinations referred to, but it is also very certain that this fact would not qualify him to hold a position as a responsible underground official. The educational value of such a book is therefore very questionable. At the same time the work has been well done. Prof. Beard has been the Principal of the School of Mines, International Correspondence Schools, Scranton, Pa., Secretary to the State Board of Mining Examiners, Iowa, and has held many other positions that qualify him thoroughly for the work that he has undertaken, and his book may be used with every confidence in its accuracy. It must, however, be borne in mind that coal mining methods, legislation, and nomenclature are so different in the United States from what they are in Great Britain that many of the answers given would prove seriously misleading to British candidates for similar positions in the latter country.

The Properties of Matter. By Prof. Basil C. McEwen. Pp. vi + 316. (London: Longmans, Green and Co., 1923.) 10*s.* 6*d.* net.

As a text-book, this work differs from its predecessors in the order of treatment of the subjects. Commencing with the First Law of Thermodynamics and the more general Principle of the Conservation of Energy, a logical sequence leads to the study of the kinetic theory of matter, which is most easily treated in connexion with the gaseous state. The continuity of the gaseous and liquid states supplies the natural transition to a detailed study of liquids, and solids are dealt with last of all. The reviewer can recommend this order from his own experience in lecturing to university students, and is of the opinion that the first half of Prof. McEwen's book reaches a high standard of excellence. Some parts of the latter half are not quite so satisfactory. The chapter on capillarity seems somewhat elementary and does not contain many references to modern work. The distinction between surface tension and surface energy is not well brought out. The chapter on solids is very short, and should be greatly expanded when a new edition is called for. We hope the author will then include an account of the crystalline structure of solids as revealed by X-ray analysis. H. S. A.

Medical Climatology of England and Wales. By Dr. E. Hawkins. Pp. xiv + 302 + 149 charts. (London: H. K. Lewis and Co., Ltd., 1923.) 25*s.* net.

EVERY practitioner of medicine is frequently required to recommend a climate suitable for convalescence or for a chronic disease; few doctors can acquire from experience the geographical and meteorological knowledge to enable them to give adequate consideration to this important detail of treatment. Dr. Edgar Hawkins provides a volume on the subject, based on his own experience and the information derived from numerous meteorological publications. The main arrangement of the book is geographical, therapeutic indications following the descriptions of the geology and climate of various districts and towns. There is also a separate chapter on therapeutics of the English climate, in which the classification is based on diseases. In one appendix the health resorts are tabulated according to seasonal suitability, and in the other the waters of the various Spas are described.

. In spite of the complexity of the subject, information with regard to locality or disease can readily be found, and reference is facilitated by the inclusion of a large number of meteorological charts and the addition of a well-prepared index. The book will be of considerable value to physicians and others interested in medical climatology.

The Elements of Co-ordinate Geometry. By S. L. Loney. Part 2: *Trilinear Co-ordinates, etc.* Pp. viii + 228. (London: Macmillan and Co., Ltd., 1923.) 6*s.*

THIS part of Prof. Loney's "Co-ordinate Geometry" contains, in order, chapters on cross-ratio geometry, trilinear and areal co-ordinates, tangential equations, reciprocation, projection, and invariants of conics. Methods of teaching geometry have advanced considerably in the last twenty years, and the arrangement adopted by Prof. Loney would scarcely be accepted as the natural one now. Trilinear and areal co-ordinates are here introduced from the purely metrical point of view. Now it would be more customary to read the chapters on projection and reciprocation first and then to treat trilinears and areals as particular cases of homogeneous co-ordinates.

Coming from an experienced teacher of mathematics, the book gives all necessary assistance to a student reading its subject-matter for the first time in the order treated. Abundant examples are given, but those on homogeneous co-ordinates include a greater proportion of metrical questions than a present-day teacher would endorse (*e.g.* pp. 85-87, Nos. 1, 2, 6, 7, 16, 17, 20, 22, 23, 24).

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

The Gorilla's Foot.

WITH regard to Mr. Akeley's cast of a gorilla foot discussed in NATURE of November 24, p. 758, I note that Sir Ray Lankester did not wait until he had seen the cast which we sent to the British Museum (Natural History) but has again made the following charges :—(1) The picture of the cast of the foot in Mr. Akeley's book "In Brightest Africa," p. 242, gave a misleading or distorted view of the cast and was in effect an example of bad photography. (2) The gorilla foot as represented by the cast differed in appearance from all previous pictures of and statements about the gorilla's foot and was misleading, chiefly because it did not show the great toe in a divergent position; it also differed in appearance from the photograph of another gorilla's foot figured by Akeley in the same book (p. 231), in which the great toe was shown in the flexed and abducted position. (3) Therefore Akeley had himself supplied the refutation of his claim that his gorilla's foot was different from any other yet discovered. (4) That it is "highly improbable" that Akeley's photograph of the cast "correctly represents the foot of a normal species or variety of gorilla."

As to (1), I have already stated (NATURE, November 24) that the photograph published in Mr. Akeley's book gave a "very fair" view of the cast in question, and after a careful re-examination of the facts I will add nothing to that statement except that Mr. Akeley has a deservedly high reputation based upon many years of experience both in photographing and in making anatomical casts, and needs no warning from any one as to the precautions to be observed in such work.

As to (2), neither Mr. Akeley nor I ever asserted that the cast in question showed the hallux in the position that it probably assumed when the animal's weight rested upon it. I quoted Mr. Akeley's statement that the cast was taken in the relaxed condition of the foot after *rigor mortis* had passed away, and I also noted that the hallux could no doubt be more or less abducted. The cast was made within twenty-four hours after death, in a cool, moist climate. The foot was cut off from the leg, the muscles and ligaments being relaxed, and was placed in a hollow in the ground with the sole facing upward. The foot and its digits were not posed but were allowed to assume the relaxed position. After being lightly soaped a thin coating of plaster was then applied and allowed to set, in order to prevent distortion by the weight of the plaster. No other outside pressure was exerted in any direction when the plaster was poured around. The whole operation was conducted with exceptional care to avoid distortion.

The outstanding feature of Mr. Akeley's cast is that it shows that in the relaxed condition the hallux assumed a position of lesser divergence, so that it was more nearly in line with the other digits. In this connexion it is pertinent to state that Dr. D. J. Morton is now studying the anatomy of the foot of another one of Mr. Akeley's adult gorillas, and finds that the arrangements of the internal cuneiform and first metatarsal bones are such that it is possible for the hallux to be drawn into the position shown in Mr. Akeley's cast. Dr. Morton has also found that in Mr. Akeley's, as well as in other adult specimens, the distal ends of the metatarsals of all the digits are twisted upon the shafts at different degrees in such a way as to make the volar surfaces face more directly downward, whereas in infant gorillas the volar surface of the hallux is tilted toward that of the other digits, this arrangement being still more pronounced in the chimpanzee. After extensive comparison, Morton concludes that the infant gorilla foot retains more of the primitive arboreal characteristics, while the adult gorilla foot shows numerous man-like adaptations not found in the chimpanzee.

As to (3), Mr. Akeley never claimed that his gorilla's feet were different from all others previously described. Such may yet prove to be the case in regard to the detailed proportions and minor characters of the foot, but it has not yet been asserted by either Mr. Akeley or myself.

As to (4), the original foot from which the cast was made has not yet been compared minutely with the other gorilla feet collected in the same general region, but after a preliminary comparison there seems no reason to brand the individual as representing an "abnormal species or variety."

In brief, Mr. Akeley's cast can be misleading only to those who read into it more than was claimed for it, or who do not realise that a gorilla's hallux may assume a position other than that figured in the previous literature of the subject. A carefully made cast of this kind is of greater scientific value than any photograph of the same object, because it represents the object in the round and without photographic distortion. A good cast, such as this unquestionably is, gives indisputable evidence of fact.

In conclusion, Sir Ray Lankester's statements in his book, "Great and Small Things," about the significance of the differences between human and anthropoid feet, suggest that he is one of several eminent persons (including Mr. H. G. Wells) who do not see that the human foot is an anatomical palimpsest, in which the later record of a long terrestrial life is so deeply impressed that it has largely obscured the underlying older record of a previous arboreal stage with a divergent hallux. This is not a "theory" but a well-founded inference from the many facts that are now being examined by Sir Arthur Keith, Dr. Morton, and others.

WILLIAM K. GREGORY.
American Museum of Natural History,
New York, December 7.

Psycho-Analysis and Anthropology.

REFERRING to the letters in NATURE from Dr. Malinowski (November 3) and Prof. Elliot Smith (November 24) on this subject, I should like to make three remarks.

(1) While agreeing with all that Prof. Elliot Smith says as to "Totem and Taboo," and that Freud failed to acquaint himself with the essential facts and associations of which he writes, this is by no means the case with all of his disciples, while even in "Totem and Taboo" there is stress laid on the quality of ambivalence in savage belief and custom, which, if I judge rightly, had not previously been sufficiently appreciated by anthropologists. It may be that Prof. Elliot Smith has recognised this in his article in the *Monist*, which I have not had the opportunity of reading.

(2) I rather doubt whether time will bear out Prof. Elliot Smith's contempt for typical symbols. Type dreams—that is, identical dreams having the same meaning attributed to them—certainly occur among peoples genetically and culturally remote. Thus, to take an example, quite superficial reading, and the kindness of friends in supplying references, indicates

that the tooth-losing dream occurs in Europe and among Nagas, Malays, and Chinese, also Ashanti, and that in each case it is taken to mean the death of a near relative (Ashanti, loss of near friend). Moreover, this meaning fits well with the individual significance commonly recognised by analysts, namely, the fear of castration.

(3) The question of "Universal Symbolism" is of course the crux of the whole matter. Are the findings of analysis for the individual applicable to the social unit to which he belongs; and if so, do they also apply to other groups which may be genetically remote?

Those interested should shortly have the opportunity of hearing the problem examined from the psycho-analytic point of view, for Dr. Ernest Jones has consented to read a paper upon this subject before the Royal Anthropological Institute on Tuesday, February 19. Tickets of admission will willingly be sent to non-members of the Institute interested in the subject, who should apply to the Assistant Secretary, Royal Anthropological Institute, 50 Great Russell Street, W.C.1.

C. G. Seligman.

Malaria and *Anopheles funestus* in Mauritius.

Early in 1922 I was asked by the Secretary of State for the Colonies to undertake an Anopheline and anti-malaria survey in the island of Mauritius. I accepted this mission, and had the pleasure of devoting ten months of intensive investigation to a survey of unusual interest.

Prior to my visit to Mauritius, a somewhat similar survey had been made in 1908 by Sir Ronald Ross, Major Fowler, and Mr. d'Emmerez de Charmoy. The valuable work they accomplished and the many interesting observations made by them are recorded in Ross's report entitled "Prevention of Malaria in Mauritius" (London, Waterlow and Sons, 1908).

In the course of their work, Ross, Fowler, and d'Emmerez de Charmoy made an extensive survey of the mosquitoes of Mauritius, which resulted in the collection of the following species:

Old Nomenclature.

1. *Myzorhynchus mauritianus.* Daruty de Grandpré & d'Emmerez de Charmoy.
2. *Myzomyia (Pyretophorus) costalis.* Theobald.
3. *Nyssorhynchus maculipalpis.* Giles.
4. *Scutomyia notoscripta.* Walker.
5. *Stegomyia fasciata.* Fabricius.
6. *Culex fatigans.* Weidemann.
7. *Culex tigripes.* Daruty de Grandpré & d'Emmerez de Charmoy.
8.[1] *Culex annuliorius.* ?
9. *Culex arboricolis.* d'Emmerez de Charmoy.
10. *Culex ronaldi.* d'Emmerez de Charmoy.
11. *Culex fowleri.* d'Emmerez de Charmoy.

Modern Nomenclature.

1. *Anopheles mauritianus.* Daruty de Grandpré & d'Emmerez de Charmoy. Very common.
2. *Anopheles costalis.* Theobald. Very common.
3. *Anopheles maculipalpis.* Giles. Very rare.
4. *Aēdes albopictus.* Skuse.
5. *Aēdes argenteus.* Poiret.
6. *Culex fatigans.* Fabricius.
7. *Lutzia tigripes.* Daruty de Grandpré & d'Emmerez de Charmoy.
8.[1] *Culex annuliorius.* ?
9. *Orthopodomyia arboricolis.* d'Emmerez de Charmoy.
10. *Culex sitiens.* Weidemann.
11. *Aēdes nigerensis.* Theobald.

[1] *Note.—Culex annuliorius* should not be listed among the mosquitoes of Mauritius, as the record is probably due to an error in identification.

It will be seen from this list that three species of Anophelinæ were found, and I have added the remarks made by these investigators relating to the prevalence of the Anopheline species.

By experimental work in Mauritius, Ross was able to prove that of the three Anophelines, *A. costalis* was easily infected with malaria and could be regarded as the chief vector; that *A. mauritianus* apparently could not be experimentally infected with malaria, and by much additional evidence could be regarded as incapable of malaria transmission; while, owing to the great rarity of *A. maculipalpis*, which these investigators state was then the case, there was no opportunity of obtaining *A. maculipalpis* in numbers sufficient for experimental work. Its presence in Mauritius was therefore considered of no practical importance at the time.

Based on these discoveries, Ross indicated the plan that should be adopted for the institution of an anti-malaria campaign in Mauritius. Unfortunately, his recommendations were not thoroughly carried out, and although much useful work was done by the canalisation of streams and the abolition of swamps in many parts of the island, the success of the campaign was vitiated by the neglect of equally important Anopheline breeding-places, and in many cases by allowing the completed anti-anopheline works to revert to natural conditions.

Consequently, fourteen years afterwards malaria in Mauritius was as bad as ever—a fact which, together with the totally insanitary state of the island, led the Governor, Sir Hesketh Bell, to decide to ask the Colonial Office to appoint an expert in tropical hygiene to visit the island and indicate the necessary measures for the correction of the many serious defects.

The Secretary of State for the Colonies called upon Dr. Andrew Balfour to undertake this mission, and Dr. Balfour left for Mauritius in February 1921. The utterly insanitary state of the island, and the very large number of separate problems with which Balfour had to contend, are fully set out in his comprehensive report, entitled "Report on the Medical and Sanitary Matters in Mauritius, 1921," published by the Colonial Office.

With regard to malaria in the island, Balfour speedily saw that, for renewed effort against the Anophelinæ, it was essential to know more of the bionomics of *Anopheles costalis*, the species then thought to be the only species responsible for the intensely malarious condition of Mauritius. His view was that it was highly important to know whether the species did or did not hibernate during the winter months, at least at the higher altitudes of the island, so that future work might take into account this most important fact.

On his return to England, Balfour recommended that investigations to determine the bionomics of *A. costalis* should be undertaken. I therefore left England for Mauritius early in 1922 to carry out this work.

For the first four months after my arrival in Mauritius (then the winter months), my staff and I gave undivided attention to the work of determining whether *Anopheles costalis* exhibited hibernation; and we were successful in showing that hibernation did not occur either at the coast or inland—a matter that is fully dealt with in my report to be published shortly by the Colonial Office.

During the work on *A. costalis*, much to my surprise I discovered that, in spite of what Ross had said in 1908, *Anopheles maculipalpis* was now to be found in very large numbers all round the island and up to an altitude of 1200 ft.

Later, with more time to devote to further studies

after *A. costalis* and the hibernation problem had been settled, my assistant and I while searching a marsh near Port Louis were astonished to find a larva of *A. funestus*. Further search in this marsh demonstrated that *A. funestus* was here in large numbers. The fact that *A. funestus* had not been recorded from Mauritius before, in spite of the work of the previous investigators, coupled with the proximity of the marsh to Port Louis—where all ships enter Mauritius—led me to assume that the species had only recently been imported. I immediately approached the Officer Administering the Government for authority and funds to abolish this marsh; and by the copious use of paraffin castor-oil mixture, while hundreds of men tore up the weeds, by drainage and filling-in operations, within a few days the marsh was changed into dry land.

Control of all the nearby waters—fortunately few—was instituted, and no larva appeared in these waters. A few days later, while I was in conversation with one of the chief moustiquiers (mosquito searchers)—an Indian who had been trained by Ross and Fowler—this man told me that he thought he remembered having seen similar larvæ while Ross was in the island, at Schonfeld Marsh, Riviere du Rempart in the north.

I questioned him further, pointing out that it was difficult to remember the appearance of larvæ after the lapse of 15 years; but he seemed so certain that I despatched him to Schonfeld to search. Schonfeld Marsh is rather inaccessible, some 15 miles from the marsh at Port Louis, and as the man had to go on foot it was two days later before he returned.

When he got back, however, he brought with him six larvæ of *A. funestus*. My assistant and I at once left for Schonfeld Marsh in my motor-car, taking the man with us, and after searching for two hours in this extensive marsh, I discovered a larva of *A. funestus* there for myself.

On my return to Port Louis, I issued instructions that all moustiquiers should divide up and proceed to all parts of the island and search only for *A. funestus*. Two weeks later, *A. funestus* had been reported from practically every district of Mauritius, but the numbers found were surprisingly few.

I then decided personally to undertake the study of the bionomics of the species, and I at last found—as I have fully described in my report—that *A. funestus* existed in Mauritius in prodigious numbers, in some localities actually outnumbering *A. costalis*. The failure to discover the larvæ in numbers before was due to the fact that the vibrations transmitted through the earth by the tread of the searchers warn the larvæ of danger, and they all dart to the roots of the vegetation, to which they cling, *or even climb a few inches up the damp surfaces of the leaves* which dip into the water. Once this fact had been discovered, thousands of *A. funestus* larvæ could always be had in suitable breeding-places.

I undertook experiments in malaria transmission by *A. funestus* and *A. maculipalpis* in the island, and found that the former species could very easily be infected, and that *A. maculipalpis* could also be infected without much difficulty. Consequently, instead of *A. costalis* being the only vector of malaria in Mauritius, there are in reality three vectors: *A. costalis*, *A. funestus*, and *A. maculipalpis*.

Now, there are two theories to account for the malaria in Mauritius:

(1) That *A. costalis* (and *A. funestus* and *A. maculipalpis* ?) have existed in Mauritius for centuries, and that it was only the importation of large numbers of Indians to work in the sugar-cane industry, bringing with them in their blood the parasites of malaria, that caused the extensive infection of the local anophelines.

(2) That prior to 1865, when the first considerable outbreak of malaria (?) occurred, no anopheline vector existed in the island, and that it was only by accidental importation of *A. costalis* (*A. funestus* and *A. maculipalpis*?) then that Mauritius became malarious.

Personally I am inclined to favour the first theory, but the following experience shows how impossible it is to be dogmatic.

Towards the end of my work in Mauritius, hearing that the sister island of Rodrigues was free of malaria, I obtained sanction from the Officer Administering the Government to proceed to Rodrigues in order to investigate this report.

The island is so small that it was possible, with the assistance of three skilled helpers, to search all the streams, marshes, and pools. No Anopheles were to be found, and no case of malaria acquired in Rodrigues existed, although on the other hand I was able to find persons with all three species of the malaria plasmodia in their blood, which they had acquired by former residence in Mauritius.

The island of Rodrigues lies 365 miles to the east of Mauritius, and is visited regularly, though only every 3-4 months, by the Government supply steamer from Mauritius. On this ship, which is berthed in Port Louis, *A. costalis* was found even during my voyage, and it seems obvious that the only thing that accounts for the fact that Anophelines have not been introduced into Rodrigues is that the island is completely surrounded by an extensive and remarkable coral reef, running from 1½-6 miles seaward, which forces all vessels to anchor at least 1½ miles from shore. Moreover, a steady wind from the south almost invariably blows across the island from the shore across the anchorage.

In my report I have described these investigations at length, but I am in the meantime asking Sir Ronald Ross if he will be good enough to add any remarks he may care to make on what these investigations have shown. MALCOLM E. MACGREGOR.

Wellcome Field Laboratory, Wisley, Surrey
(Wellcome Bureau of Scientific Research).

THESE investigations appear to me to be both theoretically and practically important. The question is whether *A. funestus* entered Mauritius after my visit in 1908. Major C. E. P. Fowler and myself were in the island from November 20, 1907, until February 25, 1908, that is, during the summer. Of course, we could not make anything like a complete survey of the mosquitoes in that time, but we were given the assistance of Mr. D'Emmerez de Charmoy, the accomplished entomologist of the island and curator of the museum, and were also provided with ten "moustiquiers," that is, trained mosquito men. Our principal investigations were made close to the Clairfond Marsh at Phœnix—which was drained in 1908; but Major Fowler and Mr. D'Emmerez investigated much further afield than this. It is therefore most surprising that we did not once come across *A. funestus*. I remember that when I first found *A. costalis* in the island I expected to discover *A. funestus* pretty shortly, partly because we had found them in association in Sierra Leone (where indeed we had discovered and named *A. funestus*), and also because we heard that both mosquitoes abounded in the neighbouring island of Madagascar. It seemed surprising to me that only one of these Madagascar Anopheles had managed to drift into Mauritius. Moreover, we heard that it

was absent from the island of Réunion, where *A. costalis* was present. I understand that Mr. MacGregor found *A. funestus* in numbers during the period of summer when we were in the island; but, in addition to all this, it is most remarkable that Mr. D'Emmerez, who was appointed in charge of the antimalaria measures after we left, had not detected this mosquito during all these years. The most likely inference appears to me to be that *A. funestus* has been imported quite recently. I wonder whether it has also appeared in Réunion.

In my report I discussed the question whether malaria had been introduced into Mauritius and Réunion in 1866–7 (as was the case) by the introduction of large numbers of coolies from India, or by the introduction of *A. costalis*, and I preferred the latter theory. Against the coolie theory there was the fact that Indians had been pouring into both islands long before those years. I thought it more likely that *A. costalis* had been brought in some time previous to 1866, possibly by some ship. If therefore *A. funestus* has been a new introduction, this hypothesis of mine will be further supported. The entire absence of both species from Rodrigues is another confirmation. The most likely picture appears to me to be that all three islands were Anopheles-free up to 1865 or so, but that two of the islands have become infected since by shipping from Madagascar. I understand that both species are absent from India, but have not been following the recent literature.

It is very disappointing that all the antimalaria measures advised by me have been allowed to fall into abeyance in Mauritius, and I have long been convinced that anti-mosquito work will not be properly carried out in British dominions until stronger discipline is enforced. RONALD ROSS.

Methods of Chemical Reactions.

THE general scheme of a chemical transformation can be reproduced by the equation:

$$\left.\begin{aligned} &x_1 A_a B_b C_c \ldots + x_2 A_d B_e C_f \ldots + x_3 A_g B_h C_l \ldots + \\ = &y_1 A_m B_n C_p \ldots + y_2 A_q B_r C_s \ldots + y_3 A_z B_u C_w \ldots + \end{aligned}\right\} \text{I.}$$

A, B, C represent chemical elements or groups of elements, which are transferred as whole complexes from one side to the other of the chemical equation (*i.e.* NH_4, SO_4, NO_2, etc.). We shall call these groups of elements for short the *elementids* of a chemical equation; the chemical elements are thus the simplest elementids. It is evident that in determining the number of elementids of a chemical equation the minimum rule must be observed—that is, the elements must be brought together into groups, so that the number of these groups (elementids) shall be the smallest possible. The composition of these groups must fulfil one condition: that their number taken as a whole and for each formula individually should be the same on the right and on the left side of the chemical equation. In most cases the problem of determining the elementids is simplified by the fact that the number of elementids is the same as the number of elements.

a, b, c, d, etc., as usual in chemical equations, are numbers showing how many times a given element (or elementid) occurs in the composition of a chemical compound. Equation (1) contains molecules composed of all elements of a given chemical transformation; of course, the absence of some elements in the composition of a particular chemical molecule is expressed by making the corresponding multiplier (*i.e.*, a or b or c, etc.) equal to zero.

x_1, x_2, x_3, also y_1, y_2, y_3, etc., are the numerical coefficients to be determined by chemists using chemical equations.

To determine these coefficients algebraically, according to the rule requiring an equal number of elements on both sides of a chemical equation, we can write:

$$\begin{aligned} x_1 a + x_2 d + x_3 g + \ldots &= y_1 m + y_2 q + y_3 z + \ldots \\ x_1 b + x_2 e + x_3 h + \ldots &= y_1 n + y_2 r + y_3 u + \ldots \\ x_1 c + x_2 f + x_3 l + \ldots &= y_1 p + y_2 s + y_3 w + \ldots \end{aligned}$$

In calculating the numerical values of the coefficients x_1, y_1, x_2, y_2, etc., as required by stoichiometry, the following rules must be observed: first, all the coefficients must be whole and positive numbers; the coefficients must not have a common divisor. This last condition is satisfied by giving the smallest possible whole number to the coefficient of the molecule occurring the least number of times in a chemical reaction.

It follows from the series of equations that the number of elementids of a chemical equation corresponds to the number of separate equations serving to determine the necessary coefficients; and the number of heterogeneous molecules (separate substances) taking part in a chemical reaction corresponds to the number of unknown quantities. Hence:

In the simplest case the number of separate substances taking part in a chemical reaction will be greater by one unit than the number of elementids.

To illustrate this we shall give several chemical equations:

(*a*) *Two elements and three substances:* An example of the simplest reaction is the formation of water (two elements, H and O, and three substances, H_2, O_2, and H_2O).

(*b*) *Three elements or elementids and four substances:*

(1) $2C_2H_4O_2 + Zn = Zn(C_2H_3O_2)_2 + H_2$; the three elementids are Zn, H, and $C_2H_3O_2$.

(*c*) *Four elements and five substances:*

$$4S + 6NaOH = 2Na_2S + Na_2S_2O_3 + 3H_2O.$$

(*d*) *Five elements and six substances:*

$$2Sr(NO_3)_2 + 6NH_4Cl = 2SrCl_2 + 5N_2 + Cl_2 + 12H_2O.$$

(*e*) *Six elements and seven substances:*

$$K_2Cr_2O_7 + 6HI + 4H_2SO_4 = K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3I_2.$$

More complex chemical equations containing more than six elementids are comparatively rarely met with in chemistry.

We shall now investigate an example in which seven elements and eight substances take part in a reaction:

$$x_1 K_3Co(CN)_6 + x_2 H_2SO_4 = y_1 CoSO_4 + y_2 K_2SO_4 + y_3 (NH_4)_2SO_4 + y_4 CO + y_5 CO_2 + y_6 SO_3.$$

By solving the algebraical equations corresponding to this chemical reaction we get the following:

$$2K_3Co(CN)_6 + 24H_2SO_4 = 2CoSO_4 + 3K_2SO_4 + 6(NH_4)_2SO_4 + 11CO + CO_2 + 13SO_3.$$

This reaction is so complex, that even Prof. Treadwell, who did not know of the algebraical method of finding the coefficients, wrote the equation wrongly from the strictly stoichiometrical point of view. His rendering of it was as follows: [1]

$$2K_3Co(CN)_6 + 12H_2SO_4 + 12H_2O = 2CoSO_4 + 3K_2SO_4 + 11CO + CO_2 + 6(NH_4)_2SO_4 + SO_3.$$

[1] Treadwell, "Analytical Chemistry," vol. ii.

Here there are seven elements, but nine substances. One need not be a profound mathematician in order to understand that according to the scheme of a chemical reaction evolved by us, Treadwell's example just given contains, in the equation of reaction, substances the coefficients of which in certain limits can be arbitrarily changed. Such substances are: on one hand, H_2SO_4 and H_2O, on the other SO_3.

Thus, if we express the number of elementids by the letter L, the number of chemical substances taking part in the reaction by the letter M, we shall get for the simplest case of a chemical equation the expression:

$$M = L + 1.$$

We have looked through a number of chemical works and have found no exceptions to this rule. The seeming exceptions, carefully analysed, were found to be only complications, substantiating the rule announced. In the well-known "Analytical Chemistry" of Prof. Treadwell (vol. i.) out of 1240 reactions, 688 follow directly the rule announced. We shall show below that the seeming exceptions are only more complex cases.

Let us consider a first possible complication: it is evident that by addition of two or several chemical equations, we obtain a new chemical equation, but a more complex one; to find in this case the applicability of the simplest rule governing a simple chemical reaction, a special analysis is required.

Let us consider the case of double decomposition, which from a chemical point of view consists of two reactions: a reaction of combination and a reaction of decomposition. This complication affects adversely the immediate applicability of the rule announced. In this case the number of elementids increases, but the new elementids give algebraical equations resulting in the same solutions as those given by the number of equations demanded by the rule $L = M - 1$, so that to find the necessary coefficients it is sufficient to take only the algebraical equations according to our rule. To demonstrate this we will take an example:

$$x_1 AgNO_3 + x_2 H_2S = y_1 HNO_3 + y_2 Ag_2S.$$

Here there are the following equations: for Ag, $x_1 = 2y_2$, for NO_3 (elementid), $x_1 = y_1$, for H, $2x_2 = y_1$. These suffice already, for by taking $y_2 = 1$, we obtain $x_1 = 2$, $x_2 = 1$ and $y_1 = 2$. It is possible to make an equation for sulphur, $x_2 = y_2$, but this equation gives no new data and can only serve to control the preceding equations.

Here is another example [2] of a complex reaction:

$$8KClO_3 + 24HCl = 8KCl + 12H_2O + 9Cl_2 + 6ClO_2.$$

The corresponding simple reactions are:

$$KClO_3 + 6HCl = KCl + 3H_2O + 3Cl_2$$
$$5KClO_3 + 6HCl = 5KCl + 3H_2O + 6ClO_2.$$

Adding together the last two equations and dividing throughout by the factor 3 common to all the coefficients, we obtain a more simple expression than that given above, for we get:

$$2KClO_3 + 4HCl = 2KCl + 2H_2O + Cl_2 + 2ClO_2.$$

Here again the "new condition," regulating the decomposition of chlorate of potassium, will be expressed by the quantitative analytical data of the percentages in the reaction products of chlorine and chlorine dioxide. These last examples show already that, as in the application of the familiar phase rule, the appearance of each "new condition" increases by one the number of substances. Designating the number of new conditions by n as in the phase rule, we get for this case the expression:

$$M_n = L + 1 + n.$$

As in the familiar case in the application of the phase rule, we can designate as *non-variant* chemical reactions those following the simple rule $M = L + 1$, as, of course, the formulæ for these reactions do not admit of a variation of coefficients. A chemical reaction obeying the rule $M_n = L + 1 + n$ has n degrees of freedom. Thus the reaction above investigated of the action of sulphuric acid on $K_3Co(CN)_6$, if written according to Treadwell, will have one degree of freedom (inter-relation of the number of molecules H_2O and SO_3), *i.e.* for this case $n = 1$ and thus $M_1 = L + 2$. Accordingly in Treadwell's equation, we have $M_1 = 9$ and $L = 7$.

The reactions of hydrogen peroxide when hydrogen peroxide acts as a reducing agent show this:

$$x_1 Ag_2O + x_2 H_2O_2 = y_1 H_2O + y_2 O_2 + y_3 Ag.$$

In this case $L = 3$ (*i.e.* Ag, H, and O), $M = 5$, *i.e.* Ag_2O, H_2O_2, H_2O, O_2, and Ag. It would seem that this is an exception to the rule; but actually there is no exception, as the last equation is subject to a new condition: the quantity of hydrogen peroxide and the quantity of silver oxide are determined by the fact that the molecule of oxygen is formed by one atom of oxygen taken from the hydrogen peroxide and one atom of the silver oxide. Algebraically this condition can be expressed by putting $x_1 = x_2$. The solution is then quite definite.

Lastly, let us investigate the case of reactions often met with in organic chemistry, where a small number of elements forms a great many substances. We will take the decomposition by water of the alloy of iron and carbon at high temperature and pressure:

$$3Fe_pC_q + 4_pH_2O = pFe_3O_4 + y_2 C_nH_{2n+2} + y_3 C_nH_{2n} + y_4 C_nH_{2n2} + \ldots$$

An immediate application of the rule $M = L + 1$ can be made only in the case of the formation of one hydrocarbon (case of double decomposition), as in the decomposition of the carbide of aluminium. To the other case the rule $M_n = L + 1 + n$ must be applied, as each new hydrocarbon must be characterised by quantitative analytical data showing its percentage in the reaction products in order to be able to write a stoichiometrically correct chemical equation.

The expression $M_n = L + 1 + n$ and the simpler one $M = L + 1$ form the basis for deducing the algebraical equations necessary for the determination of the equation coefficients of a given chemical reaction. The general number of algebraical equations will be equal to $n + L$, where L is the number of equations corresponding to the number of elementids, and n is the number of equations which must be deduced to meet n special conditions.

All the rules given in this paper can be formulated also by a single expression:

$$M_n \leqq A + 1 + n,$$

where A is simply the number of elements taking part in a given chemical reaction.

WL. KISTIAKOWSKY.

Petrograd, June 1923.

[2] Treadwell, "Analytical Chemistry," vol. i.

Mechanism of the Hydrogen Chlorine Combination.

THE object of the present note is to describe some work in progress here on an attempt to test directly the Nernst theory (*Zeit. Electrochem.*, 24, 335, 1918)

for the very wide deviation of the hydrogen chlorine combination from the Einstein photochemical equivalence law. Nernst postulated that the primary action of the light was to split up the chlorine into atoms, and that these were able to react with hydrogen molecules according to the equation

$$Cl + H_2 = HCl + H,$$

and that the atomic hydrogen formed again reacted with chlorine

$$H + Cl_2 = HCl + Cl,$$

and that this cycle was repeated over and over. Hence 1 quantum of light energy was able to cause a very great amount of combination. He showed that all these reactions proceeded with a free energy decrease and hence were possible reactions.

We are attempting to put this theory to a direct test. In our experiments atomic hydrogen, generated by Wood's method (Trans. Roy. Soc., 102-A, 1, 1922), is led into a mixture of hydrogen and chlorine, and if the theory is correct an excessively large amount of hydrogen chloride should be formed. To determine the amount of atomic hydrogen at the moment of reaction the same procedure is used substituting bromine for chlorine. It is known that the hydrogen bromine reaction does not give excessive yields of hydrogen bromide and Nernst has shown that the reaction

$$Br + H_2 = HBr + H$$

will not take place spontaneously. The hydrogen and chlorine are at a partial pressure of about 1 mm. each, and care is taken to prevent illumination of the gas mixture from the discharge tube. It has been shown so far that atomic hydrogen will travel a distance of 15 cm. from the discharge tube when the pressure is 1 mm. If chlorine be permitted to meet the hydrogen stream at this point direct combination takes place at room temperature; in one experiment the yield of hydrogen chloride was 10 per cent. of the hydrogen used. This amount would seem to exceed greatly that due to the atomic hydrogen present, although so far no direct determination has been made of this quantity.

A. L. MARSHALL.
H. S. TAYLOR.

Princeton University, Princeton, New Jersey,
November 7.

Remarkable Ascending Currents at Melbourne.

REMARKABLE ascending currents were observed during a pilot balloon ascent at Melbourne at 11.00 hours on Friday, October 26, 1923. Heights were determined by means of range-finder readings, and should have no error of consequence. The following table gives the results of the ascent:

Time.		Normal Height.	Observed Height.	Wind.	
				Direction.	Velocity.
min.	sec.	m.	m.	°	m./sec.
	45	90		335	6·8
1	30	180	176	332	10·6
2	15	270	351	325	11·3
3	00	360	801	323	10·9
3	45	450	1202	282	8·3
5	15	630	1580	272	8·8

At the first reading the balloon was too near to be observed with the range-finder. The rate of ascent should have been 100 metres in 45 seconds according to J. S. Dines's formula, but for the particular type of balloon used, range-finder observations indicate that the actual rate is about 90 metres. Shortly after the fifth observation the balloon entered thin cloud, but could be seen for some time longer.

Between the second and last reading the air in which the balloon was travelling ascended at the rate of 4 metres per second, while between the third and fourth the ascending velocity was 8 metres per second. On a number of occasions when cumulus cloud was forming, ascending rates of 2 metres per second over considerable ranges have been observed at Melbourne, but nothing approaching the velocities shown above had been encountered previously. It will be noted that the upward current was at times such that no raindrop could descend through it. A remarkable feature was that the cumulus cloud which was forming rapidly at the time was doing so, not in isolated masses, but in an almost continuous sheet. No cumulo-nimbus was present. Above the cumulus layer alto-cumulus was moving from 252°.

As regards the general situation, an anticyclone was passing to the northwards, moving rapidly. During its passage across the continent the anticyclone had decreased in intensity. Melbourne was coming under the influence of the succeeding low-pressure trough. The recent weather had been characterised by these fast-moving anticyclones, the intervening depressions being very poorly developed. This weather is one of the pronounced drought types.

EDWARD KIDSON.

Meteorological Bureau,
Melbourne,
October 29.

Long Range α-Particles.

IN a letter to NATURE of September 22, p. 435, we stated that, in addition to the α-rays of range 6·97 cm., radium active deposit emits particles of ranges 9·3, 11·2, and 13·3 cm. respectively. It has since been found that, in addition to the α-rays of ranges 4·8 and 8·6 cm., thorium active deposit emits particles of ranges 11·5 (previously recorded by Rutherford), 15·0 and 18·4 cm. respectively, and that the emission of every 10^6 α-rays of range 8·6 cm. is accompanied by the emission of 220, 47, and 55 particles of the above ranges. In the case of actinium active deposit evidence of particles of range greater than 6·5 cm. was found, but the sources available were not sufficiently intense to allow their range to be determined with accuracy.

By a method devised by Sir Ernest Rutherford we have satisfied ourselves that the long range particles from radium active deposit are α-rays.

Polonium has also been examined and found to emit small numbers of particles of ranges 6·1±0·1, 10·0±0·1 and 13·1±0·2 cm. respectively, in addition to the main group of α-rays of range 3·93 cm. The relative numbers in these new groups are at present being determined; from the brightness of the scintillations it is considered that they are α-rays.

L. F. BATES.
J. STANLEY ROGERS.

Cavendish Laboratory, Cambridge,
December 15.

Continental Drift and the Stressing of Africa.

IN reply to Dr. Evans's letter under the above title in NATURE of September 22, p. 438, may I say that I too shall be surprised, indeed extremely surprised, if further work in Uganda does not "disclose the existence of at least some normal faulting with a north and south strike, showing the former existence of east and west tension." Compression in one area seems to imply tension in another; and it is not very

probable that Africa has always been on one side of the equation. But one would expect that, had the continent been "predominantly in a state of tension," evidence of the fact would not be difficult to find in Uganda.

True, there is no reason why "a change of conditions may not convert a true rift valley formed in a period of tension into one bounded by reversed faults." But it may also be observed that it is certain that tension operating on a rift formed by a thrust action would accentuate the features, provided that the bottom of the valley was not prevented by subterranean support from sinking. Compression would do the same without the last proviso; while some such factor as cooling at depth would achieve a similar result without the assistance of either tension or compression if the faults were reversed.

There can be no shadow of a doubt that the bottoms of the Uganda rift valleys have sunk, and that, too, very considerably. What has happened beyond this it is impossible for any living soul to say with absolute certainty at present; but no theory of the rift will pass muster if it leaves Ruwenzori hanging in the air, and if it fails to explain why planes of weakness to tension have not been utilised.

Assuming a rift-block (by which I mean the mass between the rift features) bounded by reversed faults to sink, something must happen to the valley sides; either one or both will subside as a whole, or great lines of normal faulting will appear in the country on one or both sides; or these two things may happen in combination. The first of these alternatives appears, almost to the entire exclusion of the second, by Lake Albert, in Bunyoro; the second, largely to the exclusion of the first, is seen along the eastern side of Lake George. Moreover, normal faulting may appear in the rift-block itself. But all these things may equally be consequent upon settlement of a rift-block bounded by normal faults. Thus it is easily seen that step faulting is not admissible as evidence as to the nature of the fractures that initiated the rift. The solution of the Great Rift Valley problem must be sought, in fact, in places like Bunyoro, where step faulting is almost completely absent.

Dr. Evans, who combines Wegener's general proposition with a tentative theory of the moon's birth, would expect (subject to the truth of the latter) "The chief period of tension in Africa and its surroundings to have existed in Mesozoic and early Kainozoic times"; but this is precisely when, so Prof. J. W. Gregory argues (and I agree with him), Africa was being hunched up by compression.

As to the date of the moon's birth, or the manner of it, I am not qualified to speak with any authority; but I should have thought that had it taken place as late as the Carboniferous period, the parting at least would have been catastrophic. Also I am tempted to ask (not controversially, but as one seeking information) why if "the bulk of the atmosphere" was "attracted towards the protruding mass of the moon," our satellite has now no atmosphere worth mentioning. Did the moon escape without air or water; or may it not be that it once possessed both, self-elaborated very long ago, as those of the earth, in an early stage of its individual career? May not the absence of atmosphere be indicative of completion in the life of a celestial body of a stage the span of which is a function of the sphere's mass?

I fear that I have somehow created the impression that all the major faulting in this part of the world is more or less north and south. This is not so. In Bunyoro certainly, and one has reason to believe elsewhere, a series of very large east to west faults is traceable. This is clearly brought out in a structure map of part of Bunyoro prepared by Mr. W. C. Simmons a few years ago. Judging by the manner in which they cut off the north to south fractures, the east to west faults are the younger; though both are very ancient.

I believe that the word "rift" was originally applied to the Great East African fracture trough, which is quite a different thing from an ocean-covered area produced by the drifting of continents. Rift valley faults will still remain rift valley faults, whether they turn out to be normal or reversed; otherwise "rift valley" must disappear from our nomenclature should my hypothesis prove true.

I thoroughly agree with Dr. Evans's remarks with regard to the value of speculative hypothesis; and, as he reminds us, "It will only be when we have all the facts before us, that we shall be able to solve with any assurance the problems presented by the present configuration of the surface of the globe."

E. J. Wayland.

Mahyuro, Lake George, Uganda,
November 3.

Mrs. Hertha Ayrton.

In Nature of December 1 there appears under the above heading an obituary notice of the late Mrs. Ayrton which, I regret to say, is in some matters incorrect and misleading. The article is an unusual one, for in it the writer ventilates his own grievances against his so-called "masters" (The City and Guilds Institute), and disparages and belittles the work and abilities of his lifelong colleagues. To write in this strain about dead friends is in my opinion reprehensible, and it is to be hoped the example will not be followed.

From reading Prof. Armstrong's article one would gather that Mrs. Ayrton had little originality, and that all the scientific work she did was due to her husband's lead. Neither inference would be true, as is proved by the inventions she made before she met Prof. Ayrton and the original work she carried out after his death. In connexion with the latter, Mrs. Ayrton took out eight patents between 1913 and 1918.

The late Prof. Ayrton told me on several occasions that when Mrs. Ayrton took up the study of the electric arc he left the subject entirely alone so that there should be no excuse for any one giving him the credit for her work, and when lecturing to his students on the arc he made similar statements, as many of his pupils can doubtless confirm; it is indeed very probable that Prof. Armstrong heard analogous remarks from Prof. Ayrton's own lips.

T. Mather.

37 Wyatt Park Rd.,
Streatham Hill, S.W.2,
December 10.

A Waltzing Mouse.

It may perhaps be of interest to record that, in some recent experiments in crossing mice, there appeared in a litter of seven (self-coloured champagne) a female which exhibited all the symptoms associated with the Japanese waltzing mouse of which Yerkes made a fairly exhaustive study. It is dextro-rotatory, if the term be permitted. It is not yet old enough for reproduction. Both parents have, however, since produced litters, the female to a Dutch-marked male, the male on a Dutch-marked female, five and four respectively, but all are normal, nor out of eighty mice recently born to other couples have I had any other that waltzes.

G. W. Harris.

The Royal Automobile Club, London, S.W.1,
November 25.

Egypt as a Field for Anthropological Research.[1]

By Prof. P. E. NEWBERRY, M.A., O.B.E.

IT has often been stated that civilisation in Egypt spread from the south, and considerable stress has been laid upon the fact that many pre-dynastic and early dynastic remains have been found in Upper Egypt in the region between Edfu and Thinis, especially at Hierakonpolis and Naqada, and north of Naqada, in the neighbourhood of Abydos. Opposite Edfu is a desert route leading to the Red Sea; at Kûft, opposite Naqada, is the beginning of the road leading to Kosêr, the port on the Red Sea. It has been thought that the people who brought culture to Egypt reached the Nile Valley by one or by both these routes from a "God's Land" situated somewhere down the Red Sea coast. But throughout the whole history of Egypt, culture has always come from the north, and spread southwards.

From a study of the monuments of the First Dynasty that had been found at Abydos and elsewhere in Upper Egypt I ventured, nearly twenty years ago, to suggest the existence in pre-dynastic times of a Delta civilisation which, in culture, was far advanced beyond that of Upper Egypt, and I pointed out that it was probably to a Delta civilisation that the Dynastic Egyptians owed their system of writing. I was led to this conclusion by the following facts. Although many pre-dynastic cemeteries had been thoroughly explored in Upper Egypt, no grave had yielded a single fragment of hieroglyphic writing. The only inference that can be drawn from this is that hieroglyphic writing was unknown, or at all events unpractised, by the inhabitants of Upper Egypt before Dynastic times. On the other hand, the discoveries at Naqada, Hierakonpolis, and Abydos had shown us that all the essential features of the Egyptian system of writing were fully developed at the beginning of the First Dynasty. Hieroglyphic signs were already in full use as simple phonograms, and their employment as phonetic complements was well established. Determinative signs are found beginning to appear in these early writings, but, as Erman and Griffith have noticed, even as late as the Fifth Dynasty their use was very restricted in the monumental inscriptions, although they were common in the cursive and freely written texts of the pyramids. At the very beginning of the First Dynasty the numerical system was complete up to millions, and the Egyptians had already worked out a solar year of 365 days. This was indeed a remarkable achievement.

These facts are of great significance, for it is clear that the hieroglyphic system of writing, as we find it at the beginning of the First Dynasty, must have been the growth of many antecedent ages, and yet no trace of the early stages of its evolution have been found on Upper Egyptian soil. There is no clear evidence, however, that the system was borrowed from any country outside Egypt; the fauna and flora of its characters give it every appearance of being indigenous. It is apparent, therefore, that we must seek the cradle of the Egyptian system of hieroglyphic writing elsewhere than in Upper Egypt, and as the fauna and flora of its characters are distinctly Egyptian, the presumption is that it must be located in the Delta. An important indication as to the original home of Egyptian writing is given by the signs which, in historic times, were used to designate the points of the compass. The sign for "east" was a drop-shaped ingot of metal upon a sacred perch, and this was the cult-object of a clan living in pre-dynastic times in the Eastern Delta. The sign for "west" was an ostrich feather placed in a semicircular stand, and this was the cult-object of the people of the Western Delta. The sign for "south" was a scirpus-reed; this was the cult-object of a clan which dwelt on the east bank of the Nile a little above the modern village of Sharona in Middle Egypt. The country south of the apex of the Delta was known as Ta Shema, "Reed Land." It must, therefore, have been at some point north of the apex of the Delta that the scirpus-reed was first used to designate the south. It must also have been somewhere in the Central Delta that the cult-objects of the peoples of the Eastern and Western Delta were first used to designate east and west.

For the Delta being the early home of writing another fact has to be taken into consideration. Thoth, the Ibis-god, was to the Egyptians the god of writing, and it was to him that they attributed its invention. The principal seat of his worship in historic times was Hermopolis, in Middle Egypt. But Thoth's original habitat was situated in the north-east corner of the Delta, where, in pre-dynastic times, had resided an Ibis clan. The tradition that named Thoth as the god and inventor of writing would, therefore, point Delta-wards. This tradition is significant also in another way. Although we cannot doubt that the Egyptian system of writing was evolved in the Delta, the germs of writing may have come into Egypt from Western Asia *via* this north-east corner of the country. In this connexion it may be pointed out that the hieroglyphic signs for "right" and "left" were the same as those for "west" and "east"; the Egyptians who evolved the hieroglyphic system of writing orientated themselves facing south.

It is remarkable that so little is known about the early history of the Delta. Few excavations have been carried out there, and nothing of pre-dynastic, or early dynastic, times has, so far, been brought to light from the country north of Cairo. We do know, however, that before the arrival of the Falcon-kings from Hierakonpolis in the south, Middle and Lower Egypt had been, probably for many centuries, united under one sceptre, and that before these two parts of the country were united there had been a Delta Kingdom which had had its capital at Sais. The names of some of these early kings are preserved on the Palermo fragment of the famous Annals Tablet, and the list there given would alone be enough to prove how ancient the Delta civilisation must have been. There was certainly nothing comparable with it in Upper Egypt in those far-off days.

What were the physical conditions prevailing in the Delta and in the regions to the east and west of it immediately preceding the arrival of Menes in Lower Egypt? For the eastern side the evidence is exceedingly scanty, but there is one fact which is significant.

[1] From the Presidential Address delivered to Section H (Anthropology) of the British Association at Liverpool on September 17.

The chief god of the eastern nomes of the Delta in the Pyramid Age was Anzety, a pastoral deity who was the prototype of Osiris. He is represented as a man holding in one hand the shepherd's crook, and in the other the goatherd's ladanisterion. There can be little doubt, therefore, that in the Eastern Delta there lived a pastoral people who possessed flocks of sheep and goats, and this is evidence of a certain amount of grass-land. In the Central Delta at the same period there lived a series of clans, among which a Bull Clan was predominant. In historic times in Egypt the ox is often figured roaming in papyrus and reed marshes, and it may be that the Central Delta marshes supported herds of domesticated cattle.

Much more is known about the western side of the Delta at the time of Menes. It formed, I believe, part of what was called Tehenu-land; at all events this name was given to the region immediately to the west of the Canopic branch of the Nile. There can be no doubt that this part of the country was a very fertile and prosperous region in the period immediately preceding the First Dynasty. Its name signifies "Olive-land," and we actually see these trees figured, with the name of the country beside them, on a pre-dynastic Slate Palette; on this Palette, above the trees, are shown oxen, asses, and sheep of the type later known as ser-sheep. It was Menes, the Falcon-king of Upper Egypt, who conquered the people of Tehenu-land. This conquest is recorded on a small ivory cylinder that was found at Hierakonpolis. Another record of the southerner's triumph over these people is preserved on his famous Slate Palette; here the Upper Egyptian king is depicted smiting their chieftain, while on the verso of the same Palette is the scene of a festival at the Great Port, which was perhaps situated near the Canopic branch of the Nile. The mace-head of Menes, which is now in the Ashmolean Museum at Oxford, has a scene carved upon it which shows the king assuming the Red Crown of Sais, and the inscription accompanying it records that he had captured 120,000 prisoners, 400,000 oxen, and 1,422,000 goats. This immense number of oxen and goats is clear evidence that the north-western Delta and the region to the west of it (Tehenu-land) must have included within its boundaries very extensive grass-lands.

The history of this part of the Delta is most obscure. During the period that elapsed from the end of the Third Dynasty to the beginning of the Twenty-third, when Tefnakht appears upon the scene, we have scarcely any information about it. What was happening at Sais and other great cities in the north-west of Egypt during the period from 2900 to 720 B.C.? There is an extraordinary lacuna in our knowledge of this part of the country. The people living there were certainly of Libyan descent, for even so late as the time of Herodotus the inhabitants deemed themselves Libyans, not Egyptians; and the Greek historian says that they did not even speak the Egyptian language. The pre-dynastic people who inhabited the greater part of the Lower Nile Valley were apparently of the same stock as these Libyans. There is a certain class of decorated pottery which has been found in pre-dynastic graves from Gizeh in the north to Kostamneh in the south. On this decorated pottery are figured boats with cult-objects raised on poles. Altogether some 170 vases of this type are known, and on them are 300 figures of boats with cult-signs. Of these, 124 give the "Harpoon" ensign; 78 the "Mountain" ensign; and 20 the "Crossed Arrows" ensign. These cult-objects all survived into historic times; the "Harpoon" was the cult-object of the people of the Mareotis Lake region; the "Mountain" and "Crossed Arrows" were the cult-objects of the people dwelling on the right bank of the Canopic branch of the Nile. Thus it will be seen that out of 300 boats figured on vases found in graves in the Lower Nile Valley south of Cairo, 222 belong to cults which can be located in the north-western corner of the Delta. At the beginning of the historic period the cult-objects of the people of the north-western Delta included (1) the "Harpoon," (2) the figure-of-eight "Shield with Crossed Arrows," (3) the "Mountain," and probably (4) the "Double Axe," and (5) a "Dove" or "Swallow." With the exception of the "Harpoon" all these cult-objects are also found in Crete, a fact which is significant in view of Sir Arthur Evans's remark to the effect that he considers the possibility of some actual immigration into Crete of the older Egyptian element due to the first Pharaohs. The "Harpoon," it should be noted, is the prototype of the bident, and later, of the trident of the Libyan god Poseidon. Here in this western side of Lower Egypt is an almost wholly unexplored field for the anthropologist.

I have already referred to the pastoral deity Anzety, who, in the Pyramid Age, was chief of the nomes of the Eastern Delta. Among all the nome-gods he is the only one that is figured in human form; he stands erect holding in his right hand the shepherd's crook, and in his left the goatherd's ladanisterion. On his head is a bi-cornate object that is connected with goats. In the Pyramid Texts, Anzety is entitled "Head of the Eastern nomes," and these included the ancient one of the Oxyrrhynchus-fish, where, later, the ram or goat was the chief cult-animal. Neither the domesticated sheep nor the goat can be reckoned as Egyptian in origin; they both came into Egypt from Western Asia. We have, therefore, in this pastoral deity Anzety evidence of immigration from the west.

Among the cult-objects of the cities over which the god Anzety presided were two which, I believe, can definitely be referred to trees that were not indigenous to the soil of Egypt but to Syria. One of these cult-objects is the so-called Ded-column. This was one of the holiest symbols of the Egyptian religion. It has four cross-bars at the top like superposed capitals. Sometimes a pair of human eyes are shown upon it, and the pillar is draped: sometimes a human form is given to it by carving a grotesque face on it, robing the lower part, crowning the top with ram's horns, and adding two arms, the hands holding the crook and ladanisterion. Frazer has suggested that this object might very well be a conventional representation of a tree stripped of its leaves. That it was, in fact, a lopped tree is, I believe, certain. In the Pyramid Texts it is said of Osiris, "Thou receivest thy two oars, the one of juniper (*uan*), the other of *sd*-wood, and thou ferriest over the Great Green Sea." The determinative sign of the word *sd* is a tree of precisely the same form as the Ded-column that is figured on early Egyptian monuments, *i.e.* it has a long, thin stem.

This tree-name only occurs in inscriptions of the Pyramid Age, and it is mentioned as a wood that was used for making chairs and various other articles of furniture. In the passage quoted from the Pyramid Texts it is mentioned together with juniper, and the latter was employed in cabinet-making, etc., at all periods of Egyptian history. There is no evidence that juniper ever grew in Egypt, but we have numerous records of the wood being imported from the Lebanon region. The *sd*-tree, as we see from the determinative-sign of the name, had horizontally spreading branches, and was evidently some species of conifer. No conifers, however, are known from Egypt; the *sd*-wood must, therefore, have been of foreign importation. As it is mentioned with juniper, which we know came to Egypt from Syria, it is possible that it came from the same region. Among the trees of the Lebanon there are four that have horizontally spreading branches. These are the cedar (*Cedrus libani*), the Cilician fir, *Pinus laricio*, and the horizontal-branched cypress (*Cupressus sempervirens* var. *horizontales*).

Much misconception at present exists with regard to the Lebanon Cedar, because the name "cedar" is applied to a large number of woods which are quite distinct from it, and the wood which we generally call cedar (*e.g.* the cedar of our "cedar" pencils) is not true cedar at all, but Virginian juniper. The wood of *Cedrus libani* is light and spongy, of a reddish-white colour, very apt to shrink and warp badly, by no means durable, and in no sense is it valuable. Sir Joseph Hooker, who visited the Lebanon in 1860, notes that the lower slopes of that mountain region bordering the sea were covered with magnificent forests of pine, juniper, and cypress, "so that there was little inducement for the timber hewers of ancient times to ascend 6000 feet through twenty miles of a rocky mountain valley to obtain cedar wood which had no particular quality to recommend it. The cypress, pine, and tall, fragrant juniper of the Lebanon, with its fine red heart-wood, would have been far more prized on every account than the cedar." The *sd*-tree was, I believe, the horizontal-branched cypress, which is common in the wild state. In the Middle Ages this tree was believed to be the male tree, while the tapering conical-shaped cypress was considered to be the female. This is an interesting fact, because there is some evidence to show that the tapering variety was the symbol of Hathor-Isis, while the horizontal-branched one was the symbol of Osiris.

Not far from the city of Osiris in the Delta was Hebyt, the modern Behbeyt el Hagar. Its sacred name was Neter. The Romans called it Iseum. It was the ancient seat of Isis-worship in Egypt, and the ruins of its temple to that goddess still cover several acres of ground in the neighbourhood. On the analogy of other sacred names of cities the primitive cult-object here was the *ntr*-pole. This was not an axe, as has so often been supposed, but a pole that was wrapped around with a band of coloured cloth, tied with cord half-way up the stem, with the upper part of the band projecting as a flap at top. Dr. Griffith conjectured that it was a fetish, *e.g.* a bone carefully wound round with cloth, but he noted that "this idea is not as yet supported by any ascertained facts." As a hieroglyph this wrapped-up pole expresses *ntr*, "god," "divine," in which sense it is very common from the earliest times; gradually it became determinative of divinity and of the divine names and ideographic of divinity. Another common ideograph of "god" in the Old Kingdom was the Falcon (Horus) upon a perch, and this sign was also employed as a determinative of divinity and of the names of individual gods; it even sometimes occurs as a determinative sign of the *ntr*-pole, *e.g.* Pyr. Texts, 482. This use of the Falcon indicates that in the early dynasties the influence of the Upper Egyptian Falcon-god (Horus) was paramount.

There is reason, however, for believing that the *ntr*-pole cult had at an earlier period been the predominant one among the writing people of the Delta; this, I think, is shown by the invariable use of the *ntr*-pole sign in the words for priest (*hm-ntr*, god's servant) and temple (*ht-ntr*, god's house). Now, on a label of King Aha of the First Dynasty there is a representation of the temple of Neith of Sais. Here two poles with triangular flags at top are shown on either side of the entrance. Later figures of the same temple show these poles with the rectangular flags precisely as we find in the *ntr*-sign. A figure of the temple of Hershef on the Palermo Stone shows two poles with triangular flags, while a Fourth Dynasty drawing of the same temple shows the same poles with rectangular flags. We see, therefore, that the triangular-flagged pole equals the rectangular-flagged one, and that the *ntr* is really a pole or mast with flag.

Poles of this kind were probably planted before the entrances to most early Egyptian temples, and the great flag-masts set up before the pylons of the great temples of the Eighteenth and later dynasties are obviously survivals of the earlier poles. The height and straightness of these poles prove that they cannot have been produced from any native Egyptian tree; in the Empire, flag-staves were regularly imported from Syria; it is probable, therefore, that in the earlier times they were introduced from the same source. A well-known name for Syria and the east coast of the Red Sea, as well as of Punt, was Ta-ntr, "the land of the *ntr*-pole." This was the region in which the primitive Semitic goddess Astarte was worshipped. In Canaan there was a goddess Ashera whose idol or symbol was the ashera pole. The names of Baal and Ashera are sometimes coupled precisely as those of Baal and Astarte, and many scholars have inferred that Ashera was only another name of the great Semitic goddess Astarte. The ashera-pole was an object of worship, for the prophets put it on the same line with the sacred symbols, such as Baal pillars; the ashera was, therefore, a sacred symbol, the seat of a deity, the mark of a divine presence. In late times these asherîm did not exclusively belong to any one deity; they were erected to Baal as well as to Yahw. They were sign-posts set up to mark sacred places, and they were, moreover, draped. They correspond exactly to the *ntr*-poles of Egyptian historic times.

I have noted that these *ntr*-poles were tall and straight. What tree produced them? In Egyptian inscriptions there is often mentioned a tree named *tr.t*. It was occasionally planted in ancient Egyptian gardens, and specimens of it were to be seen in the Temple garden at Heliopolis. The seeds and sawdust were employed in medicine, and its resin was one of

the ingredients of the Kyphi-incense. Chaplets were made of its twigs and leaves. The tree was sacred to Hathor; branches of it were offered by the Egyptian kings to that goddess. In a Saite text it is mentioned with three other trees, pine, yew, and juniper; these are all found in Northern Syria, where they grow together with the cypress; the *tr.t* tree may therefore be the cypress. Evidence has been brought forward to show that the *sd*-tree is the horizontal-branched cypress, which was believed to be a male tree, while the tapering, flame-shaped cypress was believed to be the female tree. The Ded-column was the symbol of Osiris, and at Busiris a festival of raising this column was celebrated. The *tr.t* tree was sacred to Hathor, who is often identified with Isis, and there was a festival of raising the *tr.t* tree that was celebrated on the nineteenth day of the first month of the winter season. It is not known where this festival was celebrated, but it may well have been at Neter, the seat of the Isis cult near Dedu-Busiris. The two tree-cults point to Northern Syria as the country of their origin.

In the architecture of ancient Egypt two distinct styles can be recognised. One is founded on wattle-and-daub, the other on wood construction. Wattle-and-daub is the natural building material of the Nile Valley and Delta, and the architectural forms derived from it are certainly indigenous. Those styles derived from wood construction, on the other hand, could not have originated in Egypt; they must have arisen in a country where the necessary timber was ready at hand. Egypt produces no coniferous trees and no timber that is at all suitable for building purposes, or indeed for carpenter's work of any description. The wood of the sycomore-fig is very coarse-grained, and no straight planks can be cut from it. The sûnt-acacia is so hard that it requires to be sawn while it is green; it is very irregular in texture, and on account of the numerous branches of the trunk it is impossible to cut it into boards more than a couple of feet in length. The palaces of the early kings of the Delta were built of coniferous wood hung with tapestry-woven mats. The tomb of Menes' queen, Neith-hotep, at Naqada, was built of brick in imitation of one of these timber-constructed palaces, and smaller tombs of the same kind are known from the Second and Third Dynasties, but not later. As early as the reign of King Den (First Dynasty) the palaces of this type were beginning to be built of the native wattle-and-daub in combination with wood, and by the end of the Pyramid Age the style disappears entirely, though the memory of it was preserved in the false-doors of the tombs and stelæ. Brick buildings similar to those of the "palace" style of Egypt are also known from early Babylonia, and they were at one time regarded as peculiarly characteristic of Sumerian architecture. These, obviously, must have been copied, like the Egyptian, from earlier timber forms. In Babylonia, as in Egypt, timber was scarce, and there are records that it was sometimes obtained from the coast of Syria. This was the region from which the Egyptians throughout historic times obtained their main supplies of wood, so it is not improbable that they, as well as the Sumerians, derived this particular style of architecture from Northern Syria. I may observe in passing that in this "palace" style we have the transition form between the nomad's tent and the permanent building of a settled people.

The lack of native timber in Egypt is significant in another direction. Boats of considerable size are figured on many pre-dynastic monuments. They are long and narrow, and in the middle there is usually figured a reed or wicker-work cabin. In my view these boats were built, like many of those of later periods in Egypt, of bundles of papyrus reeds bound together with cord; they were, in fact, great canoes, and, of course, were only for river traffic. They were not sailing boats, but were propelled by means of oars. No mast is ever figured with them, but they generally have a short pole amidships which is surmounted by a cult-object. On one pre-dynastic vase there is a figure of a sailing ship, but this is totally different in build from the canoes, and it has a very high bow and stern with its mast set far forward in the hull. Similar vessels are figured on the ivory knife-handle of pre-dynastic date from Gebel el Araq, but these vessels appear to be in port and the sails are evidently lowered.

I have already referred to the Great Port mentioned on the Palette of Menes. A port implies shipping and trade relations with people dwelling along the coast or across the sea. It may be that the people of the north-western Delta built wooden ships, but if they did they must have procured their timber from some foreign source. Coniferous wood was already being imported into the Nile Valley at the beginning of the First Dynasty from the Lebanon region, and it must be remembered that the Egyptian name for a sea-going ship was *kbnyt*, from Keben, "Byblos," the port of the Lebanon, where these ships must have been built and from whence they sailed. The sacred barks of the principal gods of Egypt in historic times were invariably built of coniferous wood from the Lebanon. Transport ships on the Nile were sometimes built of the native sûnt-wood, and Herodotus describes them as made of planks about two cubits long which were put together "brick-fashion." No masts or sail-yards, however, could possibly be cut from any native Egyptian tree. In the Sûdan at the present day masts are sometimes made by splicing together a number of small pieces of sûnt and binding them with ox-hide, but such masts are extremely liable to start in any gale, and they would be useless for sea-going ships. It may be doubted whether the art of building sea-going ships originated in Egypt.

It may be doubted also whether the custom of burying the dead in wooden coffins originated in Egypt. In countries where a tree is a rarity a plank for a coffin is generally unknown. In the Admonitions of an Egyptian Sage written some time before 2000 B.C., at a period when there was internal strife in Egypt, the Sage laments that "Men do not sail northwards to [Byb]-los to-day. What shall we do for coniferous trees for our mummies, with the produce of which priests are buried, and with the oil of which [chiefs] are embalmed as far as Keftiu? They come no more." This ancient Sage raises another anthropological question when he refers to the oil used for embalming. The only oils produced by native trees or shrubs in Egypt were olive oil, ben oil from the moringa, and castor oil from the castor-oil plant. The resins and oils used for embalming were principally

those derived from pines and other coniferous trees. Egypt produced no kinds of incense trees or shrubs. The common incenses were pine resin, ladanum, and myrrh, and all these were imported. It is difficult to believe that the ceremonial use of incense arose in Egypt.

These are a few of the questions raised by a study of the material relating to the origins of the ancient civilisation of Egypt. An immense vista has been opened out before our eyes by the discoveries of the last thirty years, and now, in Egypt better than in any other country in the world, we can see man passing from the primitive hunter to the pastoral nomad, from the pastoral nomad to the agriculturist, and then on to the civilised life which begins with the art of writing. We can see in the Delta and in the Lower Nile Valley tribes becoming permanently settled in fixed abodes around primitive cult-centres, and then uniting with others into one community. We can trace the fusion of several communities into single States, and then, later, the uniting of States under a supreme sovereign. What other country in the world preserves such a record of its early history?

Rare Gas Discharge Lamps.

By J. W. RYDE, Research Laboratories of the General Electric Company, Ltd., Wembley.

A DISCHARGE of electricity through a gas at atmospheric pressure generally takes the form of a luminous spark which will pass only under a potential gradient of several thousand volts per centimetre. If, however, the pressure of the gas is reduced, the appearance of the discharge changes. First it spreads out into wavy streamers; the streamers then broaden until the discharge tube is filled with a diffuse luminous glow extending from the positive electrode to within a short distance of the cathode. This glow is known as the positive column. The cathode is now covered with a layer of bright luminosity called the negative glow, and on close inspection is seen to be not quite in contact with the electrode but separated from it by a thin and sharply defined region, known as the Crookes's dark space. Another less well-defined dark region, the Faraday dark space, is between the negative glow and the positive column. Further reduction of the pressure results in a widening of both dark spaces and the negative glow, the positive column at the same time becoming correspondingly shorter. At still lower pressures the Crookes's dark space increases until finally it fills the whole tube and there is no further luminosity of the gas.

The potential necessary to start the discharge depends on the pressure and nature of the gas, the form and material of which the electrodes are made, and also on the distance between them. In a given gas with given electrodes the starting potential is large at high pressures, but decreases, in an almost linear relation, with decrease of pressure, reaching a minimum at what is called the critical pressure, after which it rises again very rapidly. The pressure at which the minimum occurs depends on the form of the electrodes, their distance apart and the nature of the gas, but the minimum itself depends on the nature of the gas and the material and form of the cathode employed. It is about 200 volts for neon, 280 volts for hydrogen, 340 volts for air, and 420 volts for carbon dioxide. Small traces of impurity affect these values to a great extent; thus, the addition of only 0·5 per cent of pure hydrogen to neon reduces the minimum starting potential by nearly 50 volts, 5·0 per cent reduces it by about 60 volts, but if more than 5·0 per cent is added the hydrogen ceases to act as an impurity and begins to show its own characteristics, so that the starting voltage rises again. On the other hand, small quantities of other gases, such as oxygen, raise the starting potential instead of lowering it. The material of which the cathode is made has also some effect. The figures given above refer to cathodes of ordinary metals such as iron, nickel, or copper, etc., between which there are only small differences, but with magnesium, barium, or the alkali metals the starting voltage is considerably reduced; in fact, with certain alloys of these metals, the glow discharge can be started in neon at a potential so low as 90 volts and may be maintained at 58 volts.

When once the discharge has started, the potential can be lowered somewhat before the discharge stops.

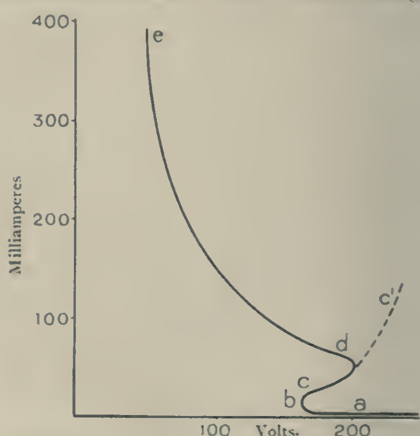

FIG. 1.

The curve connecting this "going out" voltage and the pressure is roughly similar to the starting voltage curve, but is displaced to a position somewhat below it on the voltage ordinate.

If the electrodes are only a short distance apart, so that the positive column is absent, the relation between the current flowing and the potential applied across the electrodes is that shown in Fig. 1. The states represented by the lower and upper parts of the curve are unstable, and can be observed only if there is in series with the discharge an appropriate resistance, by means of which the current may be varied. With this arrangement, when the current is only of the order of a microampere, a faint glow is seen some distance from the cathode. The potential between the electrodes falls rapidly as the current is increased, and at the same time the glow becomes brighter and assumes the form of a sharply defined patch moving nearer and nearer to the cathode as the current rises. The voltage now remains sensibly constant, being that known as the normal cathode fall, which is the lowest potential at which

the unsupported discharge can be maintained. With a further increase of current, the glow spreads laterally over the cathode, its intrinsic brilliancy and the current density remaining practically constant. A value of the current is eventually reached at which the cathode becomes completely covered with a layer of glow separated from it by the Crookes's dark space, which is only a fraction of the width of the layer of glow itself. Any further increase in current brings us to the part *c* of the curve; the voltage now increases with increase of current and the glow becomes brighter and the dark space narrower. The curve eventually becomes very steep, following the path *cc′*, and currents of the order of several amperes per square centimetre of cathode surface can be passed. At some part of the curve *cc′* the cathode begins to heat up considerably, and if composed of a refractory metal such as tungsten, will become white-hot; thermionic emission then takes place and the glow discharge passes over to the arc discharge. As soon as this begins the potential difference between the electrodes begins to decrease as the current rises, and may finally drop to only a few volts.

Gas discharge lamps may be divided into three classes, namely: (1) Lamps in which practically all the light is emitted by the positive column, (2) negative glow lamps in which the positive column is absent, and (3) lamps in which the light is emitted not from the gas but from the cathode itself, which is rendered incandescent by the discharge.

Lamps of the Moore type belong to the first class. They consist of a long glass tube filled with gas to a pressure of a few millimetres and having an electrode at each end. On account of the distance between the electrodes, the operating potential usually amounts to several thousand volts and is inconveniently high. Recently, short tubes of this type containing neon, and having electrodes made of alkali metal alloys, have been developed which will run on 220 volt A.C. supply, but require a special device giving a higher voltage for starting. These lamps are very efficient; with some of the tubes an efficiency of 0·65 watts per candle is obtainable. The colour of the light, however, is a brilliant orange red, which for many purposes is objectionable.

The second class of lamp was developed to run directly on ordinary lighting circuits. The electrodes are placed a few millimetres apart in a small bulb, the distance between them being such that the positive column is absent; this is to enable them to start and run at ordinary supply voltages. The gas used for filling the lamps is neon with about 20 per cent. of helium, which is separated with it during the process of extraction from the air. The advantages of neon are threefold. In the first place, most of the energy radiated from the glowing gas lies in the visible spectrum; secondly, the starting potential is lower than in other gases; and thirdly, the colour of the light emitted, being a yellow orange, is more suitable for illumination purposes than that from any other gas. By using hydrogen to reduce the starting voltage as explained above, and by filling the lamps to about the critical pressure (10 mm.), it is possible to make lamps having iron electrodes in which the discharge will start at about 150 volts.

The whole of the light from these lamps comes from the negative glow, which appears as a layer of bright orange luminosity about two millimetres thick completely covering the cathode, whatever its size or shape. The Crookes's dark space at the pressure used is only a fraction of a millimetre thick and is not easily seen. In consequence, the luminosity takes the form of the cathode, so that if this electrode is formed out of a sheet of metal in the shape of a letter, numeral, or similar sign, it will appear brilliantly illuminated when the discharge is passing. It is in this form that the tube is used for advertising purposes. In cases where the lamp is required for dim illumination, the cathode is made of a spiral of wire in the shape of a beehive, which ensures an approximately even distribution of light in all directions. The other electrode is either an iron wire hidden behind the letter, or a plate inside the spiral. On direct current only one electrode becomes illuminated, but on alternating current the small electrode also glows during the half cycle when it becomes the cathode.

On account of the rigidity of the mechanical construction, the lamps are robust and their life is limited only by their progressive blackening. This blackening is due to particles of the cathode which are shot off during the passage of the discharge and collect in the form of a film on the bulb. The rate at which the blackening takes place depends on the current passing through the lamp, and also varies very greatly with the particular metal used for the electrodes and the nature of the gas. The addition of impurities which lower the starting potential of the gas also considerably reduces the blackening. Thus, with iron electrodes and pure neon, the useful life of the lamp would only be about 80 hours, while with an addition of a small percentage of hydrogen the life becomes of the order of 1000 hours or more. A series resistance placed in the caps of the lamps makes them suitable for various voltages, and at the same time reduces the current to a value leading to a reasonable life.

These lamps, in common with all forms of Geissler discharge tubes, possess many properties which are valuable for purposes other than that of lighting. For example, when running on the part *ab* of the curve of Fig. 1 they can act as a negative resistance and can be used to generate oscillations. They are also sensitive detectors of current; the luminosity produced by a current of one microampere is easily seen if the lamp is shielded from direct daylight. But these other developments cannot be treated here.

In the third class of lamp, the electrodes are usually tungsten spheres about one millimetre in diameter and placed one millimetre apart. The bulb is filled with neon to about 50 mm. pressure. When first switched on, an intense glow discharge takes place which heats the cathode white-hot; a thermionic emission then ensues and the potential across the lamp drops to about 25 volts, the current being 1·0 to 1·25 amperes, the remaining volts being dropped in the series resistance. The lamp at this final stage operates in the region *e* of the current voltage curve shown in Fig. 1. The white-hot tungsten ball acts as a very intense point source of light suitable for projection purposes. The Pointolite lamp is a variant of this form, in which the discharge is initiated by means of a tungsten spiral heated electrically, the heating current being cut off when the lamp has started.

Obituary.

Lieut.-Col. H. H. Godwin-Austen, F.R.S.

The death, on December 2, of Lieut.-Col. Henry Haversham Godwin-Austen in his ninetieth year removes the last of the great pioneers in the geography of the Himalaya and a leading authority on Indian Mollusca. Col. Godwin-Austen was born at Teignmouth, July 6, 1834. He was a fellow-student with Lord Roberts at Sandhurst, whence they both went to India at the end of 1851. Godwin-Austen saw service the next year in the second Burmese War. His scientific tastes, which were hereditary—for his father, R. A. C. Godwin-Austen, was a geologist who has left an enduring reputation owing to his exceptional insight—led him in 1857 to join the Indian Survey Department. It was his privilege to survey northern Kashmir, where he discovered the Baltoro, Hispar, and Biafra Glaciers—the greatest group of valley glaciers in the world. They were afterwards traversed and mapped by Sir Martin Conway, who named the tributary glacier to the Baltoro from K_2 the Godwin-Austen glacier. The glaciers were described by Godwin-Austen in a short paper in the Proceedings of the Royal Geographical Society (vol. viii., 1864), the discussion on which is remarkable for Falconer's advocacy of the pre-glacial age of the Alpine lake basins and their preservation by the protective action of glaciers. During this survey Godwin-Austen fixed the position and heights of many of the giant peaks of the Karakorums, including K_2, which had been previously discovered by Montgomerie. It is often known as Mt. Godwin-Austen, and according to the heights adopted by the Indian Survey Department is the second highest mountain in the world.

While Godwin-Austen was working in this district he made many mountain ascents, of which his highest was on Mata, 20,600 ft., in 1862. In 1863–64 he was engaged in the survey of the eastern parts of the Himalaya around Darjeeling and in Bhutan, and, later still, further east on the Khasia Hills and in Assam. His views on the geographical structure and classification of the Himalaya were stated forty years ago in his presidential address to the Geographical Section of the British Association, which is his most important geographical paper. He contributed to the Geological Society several papers which made important additions to the geology of the Himalaya, including the discovery of the extension into Kashmir of the Spiti series, the most significant horizon in the Himalaya. In 1884 he described the drifts exposed in a new railway cutting near his home at Guildford, and the paper was illustrated by sections, characterised by the same precision and detail as those issued with his Indian papers.

After leaving the Indian Survey, Godwin-Austen's main interest was in the land mollusca. He was described as having "a unique knowledge of Indian molluscs." He contributed to "The Fauna of British India" the volume on the Testacellidæ and Zonitidæ. The value of his work on that group is shown by his election as president of the Malacological Society in 1897–9, and of the Conchological Society in 1908–9. His later years were burdened by financial embarrassment due to an unfortunately worded will. He inherited the paternal estate of Shalford, which proved a vampire instead of the source of a comfortable income. His interest was subject to fixed charges which, when the value of land fell, used up more than the whole of the income from the property. He bore this trouble with his characteristic courage and cheerfulness. Great sympathy was also recently felt for him, owing to the unfortunate loss of the portofolio of sketches and maps made during his Kashmir service, sixty years ago.

Godwin-Austen was elected F.R.S. in 1880, and received a belated Founders' Medal from the Royal Geographical Society in 1910.

Herluf Winge.

It is with much regret that we record the sudden death, on November 10, at Copenhagen, of Herluf Winge, who for many years, and until his death, was "Viceinspektor" in the Zoological Museum of the University of Copenhagen. As a lad Winge began to study the small mammals of Denmark, and his earliest papers upon this subject were full of promise. A little later, in 1877, while still a student in the University of Copenhagen, he published an account of some of the skull characters in the mole, shrew, and other Insectivora, in which he displayed not only remarkable learning but a most clever technique. In 1882 he gave his views upon the mammalian dentition and his theory of cusp homologies in a paper which will ever be regarded as a classic. In the same year appeared an account of a collection of mammals from Greece; and in preparing this Winge was led so far afield investigating the relationships and special adaptations of the species before him that he himself regarded this piece of work as the foundation of the important publications next to be noticed.

Between 1887 and 1915 Winge published a series of works which ostensibly are descriptions of the fossil bones collected by Lund in the caves of Lagoa Santa, Minas Geraes, Brazil, and of the recent mammalia obtained in the same region by Lund and Reinhardt. Taking these mammals order by order (Rodents, 1887; Chiroptera, 1892; Carnivora, Primates, 1895; Marsupials, including Monotremes, 1897; Ungulates, including Sirenia, 1906; Edentates, 1915), Winge commenced each memoir with a description of the Brazilian material; but, that finished, he proceeded in each case to give a review of the whole order, bringing out his views of the evolution and relationships of the orders and of every fossil and living family and genus in a wonderfully clear and concise style. He seems to have prepared a complete monograph of each genus dealt with; and then to have compressed each monograph into a short paragraph and very often into a single sentence. But in this small space he contrives not only to state all that is essential, but to throw many a brilliant beam across what was previously obscure. Companion reviews of the Insectivora (1917) and the Cetacea (1919), the two orders not represented in the Lagoa Santa material, have since been published by Winge. That dealing with the Cetacea has recently been translated from the Danish by Mr. G. S. Miller

and published in the Smithsonian Miscellaneous Collections.

A collected and revised edition of these reviews, in three volumes, under the title of "Pattedyr-Slægter," is at present passing through the press; and the first volume of this work was received in London on the day before Winge's death. This new and more convenient edition will be welcome, for it is but bare justice to state that the reviews in question constitute together the finest, most comprehensive, and most inspiring technical account of the class Mammalia that has ever been written.

Many other papers dealing with the mammals of Greenland and the fossil mammals and birds of Denmark were published by Winge. In 1908 he contributed the volume on Danish Mammals to the series of handbooks entitled "Danmarks Fauna"; and this little book, illustrated by Winge himself, is at once admirable and inimitable.

Reviewing the whole of Winge's published work, one cannot fail to be struck by an extraordinary fact. It is that in his writings one does not mark the flight of time. He seems to have acquired his full mental power and his own peculiar way of looking at things at an extremely early age; for his early papers of 1877 and 1882 read to-day, exactly like that of 1919, as the work of a great master. M. A. C. H.

WE regret to announce the following deaths:

Prof. F. Clowes, emeritus professor of chemistry and metallurgy and first principal of University College, Nottingham, and the author of well-known text-books on analytical chemistry, on December 18, aged seventy-five.

Canon T. Wood, well known for his natural history studies, on December 13, aged sixty-one.

Current Topics and Events.

Two octogenarian fellows of the Royal Society celebrated their birthdays this week. Sir Archibald Geikie, O.M., the Nestor of British geology, who was elected to the Royal Society so long ago as 1865, attained the age of eighty-eight on December 28, and another distinguished geologist, Sir W. Boyd Dawkins, elected to the Society in 1867, was eighty-five on December 26. To both of them the congratulations of all scientific workers will be heartily accorded. Sir Archibald Geikie, who figured as a "Scientific Worthy" in NATURE thirty-one years ago (January 5, 1893), has a world-wide reputation. As a geologist, and as the author of the "Text-book of Geology," originally published in 1882, and of other standard works on geology and geography, he is known everywhere. This is in great measure due to the way in which Sir Archibald is able to quicken interest in his subject by the expression of his deep and intense feeling for Nature. No one has done more to link geology with appreciation of the natural beauty of scenery. His work as an original investigator in geology and as a writer of inspiring volumes on this subject and on physical geography won for him the Royal medal of the Royal Society in 1896. From 1908 until 1913 Sir Archibald served as president of the Royal Society, while he was president of the British Association at the Edinburgh meeting in 1892. For the period 1882–1901, he was Director-General of the Geological Survey of the United Kingdom and Director of the Museum of Practical Geology. In spite of his advanced age, Sir Archibald maintains his active interest in both science and literature, and so recently as 1918 he produced a notable volume of Memoirs of John Michell, who died in 1793, one of the early workers in geology.

SCIENTIFIC societies and other bodies organising conferences for next year should know that the authorities of the British Empire Exhibition to be held at Wembley have constructed an admirable congress building containing four conference halls, with appropriate committee rooms, etc., capable of seating 2140, 550, 180, and 150 persons respectively. These halls are being allocated to responsible organising committees free of charge, and early application should be made for the use of any of them, as the dates are being filled up rapidly. The following scientific and technical societies, among others, have already booked one or more of the halls for conferences on different dates: The British Engineers' Association, the British Electrical and Allied Manufacturers' Association, the Institution of Sanitary Engineers, the Textile Institute, the Society of Dyers and Colourists, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Automobile Engineers, the Museums Association, the Horace Plunkett Foundation, the Health Propaganda Association, the Association of British Chemical Manufacturers, the Institution of Mining and Metallurgy, the Municipal Electrical Association, the Electrical Contractors' Association, and the Gas Association. Applications for use of the halls on dates still open should be sent to the Secretary, Conference Committee, British Empire Exhibition, 16 Grosvenor Gardens, London, S.W.1.

WITH the approaching retirement of Prof. S. Alexander from its chair of philosophy, the University of Manchester loses the services of one of the most original of the elder generation of thinkers. Nearly fifty years ago, he came from Australia to Oxford, where he gained reputation by a rare power of winning first classes. He soon, however, deserted other pursuits for philosophy, and won an assured position before he was thirty by his remarkable book on "Moral Order and Progress." Called in 1893 from a tutorship at Lincoln College to succeed Robert Adamson at Manchester, he has represented philosophy there for more than thirty years. At Oxford he was conspicuous in the reaction against the philosophy of T. H. Green, and was among the first to preach to an unheeding university the importance of modern psychology. But he never lost a bent for metaphysics and for vigorous thinking about fundamentals. His philosophic position was fully revealed in his Gifford lectures at Glasgow on "Space, Time, and Deity," published in 1920. A book so technical defies

analysis, and it is enough to say that, though many disagreed with his doctrine, there was an absolute consensus among experts that it was a contribution of the first importance to philosophic thought. Yet few philosophers have lived less in the clouds, and Alexander has not only discharged meticulously the duties of an exacting chair, but has also been prominent in many university and public activities. Ever a keen champion of the higher education of women, he took a foremost part in the foundation of Ashburne Hall, the women's hall of residence, the secretaryship of which he is resigning on his retirement from university life.

The first part of the funeral service for Canon T. G. Bonney was held in the Chapel of St. John's College, Cambridge, on December 12. Among those present were the following fellows of the Royal Society: Prof. A. C. Seward and Prof. J. E. Marr (Geological Society), Mr. C. T. Heycock (Cambridge Philosophical Society), Prof. E. J. Garwood (Alpine Club), Sir Clifford Allbutt, Prof. H. F. Baker, Mr. F. F. Blackman, Sir Joseph Larmor, Dr. G. D. Liveing, Sir Ernest Rutherford, Prof. W. T. Sollas, Sir Joseph Thomson, Prof. W. W. Watts, and Prof. J. T. Wilson.

The Council of the Royal Meteorological Society has awarded the Symons gold medal for 1924 to Dr. Takematsu Okada, Director of the Central Meteorological Observatory, Tokyo, Japan. The medal is awarded for distinguished work in connexion with meteorological science, and will be presented at the annual general meeting on January 16.

The discussion before the Illuminating Engineering Society on December 11 was concerned with a problem that confronts many of those who are associated with applied science—the best method of disseminating technical information amongst the general public. Illumination involves an appeal to the eye, and influence is best brought to bear through the medium of actual demonstrations of good and bad methods of lighting. Details of actual experience in practice, for example, of improved output and greater freedom from accidents resulting from better lighting, are also of great value. But in order to be convincing, such data must be derived from scientifically conducted tests and backed by recognised authority. Mr. Dow mentioned some of the work which the Society is doing in this connexion—for example, in co-operation with representatives of the printing trade and with the British Industrial Safety First Association. A considerable part of the discussion was devoted to the question of the high values of illumination now being advised in some quarters. The view was expressed that such recommendations must be based on scientific method, and that the desired conditions are best ascertained by experiments conducted with the aid of leading industrial councils. This same point also came up for consideration in a discussion initiated by Mr. W. P. Fanghaenel and Mr. W. N. Booth before the Institution of Civil Engineers on December 12, when Mr. L. Gaster explained the procedure of the Home Office Departmental Committee concerned with industrial lighting and emphasised the distinction between values desirable in practice and legal minima.

In order that donors might have the opportunity of seeing the premises and the equipment of the Department of Glass Technology at the University of Sheffield, a series of luncheons have been arranged, the first having been given by Mr. W. F. J. Wood, chairman of the Glass Research Delegacy, on November 15, and the second of the series by Prof. W. E. S. Turner, president of the Society of Glass Technology, on December 13. The new premises, which cover three-fourths of an acre, were, until the end of 1920, in occupation as an actual glass works. Since being purchased at a price of 9000*l*., considerable alterations have been made, a set of laboratories and small library constructed, whilst the other buildings have been adapted and equipped with plant for experimental glass melting. In this connexion there are furnaces capable of melting glass on any scale between a few grams and about 120 lb., the firing being by town's gas and compressed air, whilst a large two-pot recuperative furnace fired by oil has a capacity of two pots each of about 15 cwt. There are, in addition, a block of buildings devoted to the making of all sizes of clay pots, store rooms for the glass-making materials, a room for mixing, a machine room, smith's shop, compressor house, etc. Courses of instruction lead to the degree of B.Sc.Tech. and higher degrees. In addition, however, to the normal teaching work of the Department, a great deal of experimental work has been done for individual manufacturing firms, whilst since 1917 no fewer than 96 papers involving research have been published from the Department. The Department has no endowment, but the glass industry has been very appreciative of the work done and has contributed generously towards its maintenance.

Mr. T. W. T. Tuckey, who was in Japan at the time of the great earthquake, had an opportunity shortly afterwards of visiting both Tokyo and Yokohama, and gives the results of his observations in *Engineering* for November 30. The framework of the ordinary Japanese house is made of very light uprights secured, by tenons only, to other light horizontal members at the floor and ceiling. The floors and ceilings are wood, and the inside divisions are of wood and paper. When a severe shock causes the tenons to break, the structure closes up and pins down any occupants who do not escape quickly. The charcoal fires are also pinned and thus fires are started. It is almost inconceivable that up to August 31, 1923, such buildings were still being constructed in the capital city of Tokyo. Temples are also built of wood and have nothing but horizontal and vertical timbers in their construction; the timbers, however, are very massive, and such buildings stand up well against earthquakes and storms. In Tokyo, the first brick buildings of any importance were put up by the Government; nearly all these buildings survived the shock, though a few were burned. It will be remembered that the fires, started by the collapse of the more flimsy buildings, destroyed a large part of Tokyo. Tokyo station

building, three and four stories high and some hundreds of feet long, constructed of red brick, was not damaged by either earthquake or fire. Reinforced concrete buildings in Tokyo did not come off so well as the better-class brick buildings. Much of the brick facing has come away and there are cracks in the concrete. They are, however, probably the safest buildings for the inhabitants, and office buildings of this class have continued in use without interruption. The behaviour of steel frame buildings was peculiar; from a few feet above the ground the brickwork is cracked, and this continues for two or three stories. Above the third and up to the top (in some cases eight stories) no damage whatever is to be seen. The writer was nowhere able to find the slightest sign of failure of the foundations of any building, whether wrecked or standing.

The report for 1922 of the director of the Bernice Pauahi Bishop Museum at Honolulu has recently been issued. It gives a summary of the various activities of the Museum officials in researches relating to the natural history of the Pacific Islands and the culture and folk-lore of the Hawaiians and other Polynesian people. A number of expeditions for systematic survey in anthropology, botany, and zoology have been undertaken in connexion with the Museum. The most important were the Whitney South Sea expedition, an expedition to Fanning Island, the exploration of Guam in the Ladrone Islands, and the Bayard Dominick expedition for the investigation of the origin, migration, and culture of the Oceanic people. Some interesting general conclusions have been reached by the members of the Dominick expedition with regard to the Polynesian population. There seem to be two basic elements. The first is Caucasian with physical characteristics approaching some Mongols, with tall stature, moderately long heads, relatively high narrow faces and noses, light brown skin, and straight or wavy black hair. The second element is the Indonesian typical of Celebes, with shorter stature, low broad faces, wavier hair and darker brown skin. A third element is found only in small numbers with very short heads, narrow faces, and light skin. The second type is characterised by a higher social and religious development than the first. The first type is universally distributed in the Pacific, but strongest in New Zealand and the Marquesas. The second type is prevalent in North and Central Polynesia. In the report Mr. J. F. Illingworth notes that the Hawaiian house-fly is not the same as that of Europe and the United States, but is a variety found on the western shores of the Pacific. As it is known that these flies follow man, and there were house-flies in Hawaii when Captain Cook arrived, the inference is drawn that the original immigrants and the flies came to Hawaii from the west.

Applications are invited by the secretaries of the Royal Society for the Armourers and Brasiers' Company research fellowship in metallurgy, tenable in the first instance for two years, with a possible extension to five years. The research undertaken by the successful candidate must be connected with base metals and alloys, preferably those used in the ancient crafts of the Company of Armourers and Brasiers. The annual value of the fellowship is 500*l*. Applications must reach the secretaries of the Royal Society, Burlington House, W.1, by March 1 next.

We have received the annual report of Livingstone College, Leyton, for 1922–23, being the thirty-first year of its existence. The College gives courses of instruction with the object of teaching missionaries how to care for their own health, and how to deal with the diseases of the people among whom they are working, when far from qualified medical aid. Altogether 752 students have passed through the College. Donations and subscriptions are requested to help carry on this useful work.

The ninety-second annual meeting of the British Medical Association will be held on July 18-26, 1924, at Bradford, under the presidency of Mr. J. Basil Hall, consulting surgeon to the Royal Infirmary, Bradford. The presidential address will be delivered on July 22. The following presidents of sections have been appointed:—Medicine: Prof. A. J. Hall; Surgery: Sir Cuthbert Wallace; Obstetrics and Gynæcology: Mr. J. S. Fairbairn; Pathology and Bacteriology: Prof. C. H. Browning; Neurology and Psychological Medicine: Dr. T. G. Stewart; Ophthalmology: Dr. A. M. Ramsay; Public Medicine and Industrial Diseases: Mr. H. Jones; Diseases of Children: Dr. L. Findlay; Laryngology and Otology: Dr. W. J. Horne; Orthopædics: Mr. R. C. Elmslie; Medical Sociology: Mr. A. Manknell; Dermatology: Dr. J. MacL. H. MacLeod. The honorary local general secretary is Dr. W. N. West Watson (Victor Lodge, Manningham, Bradford).

The Seismological Society of America has published a large Fault Map of the State of California (three sheets and a title-sheet) on the scale of 1 : 506,880, or close on one inch to eight miles. The topography is based on various official surveys, the hills being well brought out by a system of colour-shading. The sea-depths are shown by contours drawn at intervals of 100 fathoms. The known and probable faults, which mean so much in the moulding and instability of the continental edge, are marked by lines of various colours; these are broken where details are uncertain or inferred. A fault indicated as "active" is usually one along which an earthquake has occurred during historic time. The mind of the world has been once more riveted on the uncertainties of the Pacific ring, and this map, which must be mounted as one wall-sheet for its proper appreciation, will no doubt find a permanent place in colleges that respect geography. Prof. Bailey Willis has furnished a lucid description to accompany the sheets (Bull. Seism. Soc. America, vol. 13, No. 1, 1923).

A report by the Meteorological Department of the Government of India for 1922–23 has just been issued under the superintendence of Mr. J. H. Field, the officiating Director-General of Observatories. The policy of Indianisation has been adopted, and the personnel for the thirteen posts of meteorologists has changed from 10 Europeans and 3 Indians in 1919 to

3 Europeans and 10 Indians in March 1923. A study of upper air movements in India is said to be laying the foundation for types of forecasting not hitherto possible from surface observations. The whole system of warnings for storms and cyclones over the sea and on land throughout India is the duty of the headquarters staff, and all is now done from Simla. Considerable retrenchment has been made during the year, which has involved the partial stoppage of Bombay, Madras, and Calcutta Daily Weather Reports, the issue being suspended during the seasons of least rainfall. Shipping at sea is supplied with the latest information regarding the weather by wireless bulletins. Upper air research shows that at heights of 4 miles and upwards the cold weather winds of northern India often reach a strength of 100 miles per hour or more, while calms prevail at the surface. At Agra the westerly components of upper air, at a height of about 4 miles, prevailing from the middle of September to the middle of October, show a close relationship with the precipitation in north-west India in the winter following. Departmental observatories for the year consist of 5 first class, 185 third class, 23 fourth class, and 24 fifth class. Rainfall observations are received from 2926 stations.

Messrs. Hawksley and Sons, 83 Wigmore Street, W., have forwarded to us their catalogue of medico-diagnostic, physiological, anthropometrical, psychological, and chemical apparatus. Several forms and sizes of capillary pipettes for the accurate measurement of quantities from 0·005 c.c. to 1·0 c.c. are listed, as well as several types of hæmacytometers and hæmoglobinometers for the estimation of the number of corpuscles and amount of hæmoglobin in blood. Under blood analysis apparatus we find outfits for the estimation of calcium, urea, and sugar in the blood. Galton's finger-print outfit and whistle and many pieces of anthropometric and psychological apparatus are catalogued. Messrs. Hawksley are also agents for the microscopes and accessories of the Spencer Lens Co., New York.

In the "Fauna of British India" Series the further volumes which the editor, Sir Arthur E. Shipley, with the assistance of Dr. Hugh Scott and with the sanction of the Secretary of State for India, has arranged for are: volumes on Butterflies (Lycænidæ and Hesperiidæ) by Mr. N. D. Riley; on the Ixodidæ and Argasidæ by Prof. G. H. F. Nuttall and Mr. C. Warburton; on Leeches by Mr. W. A. Harding and Prof. J. Percy Moore; on the Curculionidæ by Dr. G. A. K. Marshall; on the Carabidæ by Mr. H. E. Andrewes; on the Meloidæ by Mr. K. G. Blair; on the Erotylidæ and Endomychidæ by Mr. G. J. Arrow; on the Culicidæ by Capt. P. J. Barraud, Major S. R. Christophers, and Mr. F. W. Edwards; on the Chrysomelidæ (subfamilies Chrysomelinæ and Halticinæ) by Mr. S. Maulik; on the Scolytidæ and Platypodidæ by Lt.-Col. Winn Sampson; together with a revised edition of Mammalia by Mr. Martin A. C. Hinton and Mr. R. I. Pocock, and of Birds (6 vols.) by Mr. E. C. Stuart Baker.

The latest catalogue (New Series, No. 10) of Messrs. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, should, we think, be very useful to librarians and others, it being a classified list of some 840 serials and transactions of scientific societies on sale by them. The catalogue is conveniently arranged under the headings: British Isles—Transactions of societies and other scientific periodicals; British Isles—Proceedings of local societies; Dominions and Colonies—scientific serials. etc.; United States of America—scientific serials, etc.; and foreign countries—scientific serials, etc.

Our Astronomical Column.

The January Shower of Meteors.—This display of meteors is of greater importance than is supposed. It sometimes furnishes a rather brilliant exhibition of a conspicuous character, being more brilliant than the average and traversing longer paths. The radiant point is situated at about 230° + 53° in the region barren of bright stars lying on the borders of the constellations Boötes, Draco, and Hercules.

The shower has occasionally been so abundant as to furnish one or two meteors per minute. In the evening hours, from the latitude of England, the radiant point is situated at a low altitude in the northern sky, and it is generally in the few hours preceding sunrise that the display attains its greatest strength. Unusually rich returns of these meteors were witnessed in the early evening hours of January 3, 1918 and 1922, and we may expect another plentiful exhibition of its meteors on the morning of January 4 next between about 4 and 6 a.m. The moon will not offer any obstruction on that date, as it will be 26 days old and visible as a very narrow crescent only.

Should the weather be clear on the morning of January 4, all the conditions are promising for a meteoric spectacle of very interesting character, and it will be important to observe it carefully through the night in order to determine the hourly number of meteors visible and the time when it reaches a maximum.

The Axis of Mars.—*Popular Astronomy* (November) contains an interesting study by Prof. W. H. Pickering of the position of the axis of Mars. He notes that the method used by Lowell of observing the polar caps is subject to a systematic error. The edge of the cap has a sensible diurnal shift: the white deposit melts on the noon side of the cap, and forms again on the opposite side. Accordingly a new determination was made, based on a large number of small well-defined markings spread over the disc. Incidentally the conclusion was reached that a large number of the Martian spots have a sensible annual shift, easily explicable on the view that they are vegetation phenomena. This, however, can be eliminated from the discussion. Prof. Pickering's final value for the obliquity of the Martian equator to its orbit is 24° 14′, a degree greater than Lowell's. He gives for the co-ordinates of the point to which the N. pole is directed—

$$\text{R.A.} = 20^h\ 58^m\ 6^s + 1{\cdot}56^s\ (t - 1918)$$
$$\text{N. Decl.} = 52°\ 12'\ 50'' + 12{\cdot}6''\ (t - 1918).$$

The equinox of the planet is shifted back 7·16° from 87·89° to 80·73°. This has the effect of increasing the Martian date by 14 days. The method employed seems to give this determination more weight than any other that is based on markings on the disc.

Research Items.

The Cave of Macpelah.—In the concluding issue for the year of *Ancient Egypt*, Sir Flinders Petrie discusses the probable position of the double cave below the Herodian monument which is described in the lately published "Hebron, le Haram el Khalil," by Père Vincent and Captain Mackay. Owing to the fanaticism of the present Arab population, the authors of this work were not allowed access to the subterranean parts. Our knowledge of these is derived from an account, written in A.D. 1136, of an examination of them in A.D. 1119 by the monks. Sir Flinders Petrie's conclusion is that the double cave probably lies to the S.E. rather than to the N.E. of the basilica-like chamber to which the monks penetrated. A point of interest in connexion with the superstructure is that while the internal proportions indicate the Jewish foot as the unit, those of the exterior conform to the Roman foot, the design being based on the fact that the two units can be worked together on a ratio of 10 : 11 in the length or 11·5 : 12·5 in the breadth.

Rock Paintings in Papua.—Dr. W. Mersh Strong has published in the December number of *Man* photographs and tracings of a number of rock paintings from the Central District of Papua. They were found on a prominent whitish rock, and were executed in a single monochrome red, apparently a preparation of iron oxide. The designs included a cassowary, a figure of a man, a scroll pattern, a double chevron with pendent lines, possibly a tortoise, a man's face, a crescent, and a hand. There is nothing to indicate their age except that they are covered with a slight film, probably of calcium carbonate derived from the trickling of water. The present natives have no knowledge as to who did them. Dr. Strong is of the opinion that the face design suggests the face *motif* of the Papuan Gulf, but points out that this culture has its centre some two or three hundred miles west of Port Moresby and scarcely comes within a hundred miles of that area. He also refers to the paintings of canoes and men in red monochrome seen by Seligman in the Marshall-Bennet Islands.

The Copper Eskimo.—Two further instalments of the Report of the Canadian Arctic Expedition 1913–1918 have just been issued; these are "The Physical Characteristics of the Copper Eskimo," by D. Jenness, and "The Osteology of the Western and Central Eskimo," by John Cameron, being parts B and C of volume xii. The measurements given by Mr. Jenness were, for the most part, taken at Coronation Gulf, where the expedition spent two years. Mr. Jenness concludes that there is strong support for Boas's view that Indian admixture in Alaska has increased the stature and produced a marked tendency towards brachycephaly; and that while the Copper Eskimo show more resemblance to the Eastern Eskimo than to the Alaskan, they differ from most other Eskimo in that the head is slightly longer and broader, although the cephalic index is virtually the same as among the pure-blooded tribes to the eastward. It is interesting to note that Mr. Jenness finds no evidence to support Dr. Stefansson's theory of European admixture among the Copper Eskimo. Of the features principally relied upon by Dr. Stefansson, Mr. Jenness holds that the proportion of face breadth to head breadth is illusory, and the blue or grey tinge of the eye is pathological in origin and common elsewhere.

Causal Organism of Potato Blackleg.—As the result of a study of twelve strains of the potato blackleg parasite, including the four "species" originally described as the cause of the disease, H. M. Jennison concludes, in a paper published in the Annals of the Missouri Botanical Garden, vol. x. No. 1, February 1923, that the blackleg disease of Irish potatoes in North America and Europe is caused by a Schizomycete which should bear the name *Bacillus atrosepticus* van Hall. The following names are to be considered only as synonyms: *Bacillus phytophthorus* Appel, *B. solanisaprus* Harrison, *B. melanogenes* Pethybridge and Murphy. The pathogen infects the stems and the tubers of the potato. Virulence of the parasite, as tested by artificial inoculation, appears to be dependent upon a rather delicate balance of temperature and water relations, and upon the sugar content of the tissues inoculated.

Cytology of Mutation.—Prof. R. R. Gates has an important paper in the *Annals of Botany*, vol. xxxvii. No. 148, October 1923, under the title "The Trisomic Mutations of Œnothera," in which he describes the occurrence in the F_1 generation of the cross *Œnothera rubricalyx* × *Œ. Hewettii* of a mutant with fifteen chromosomes, and discusses in connexion therewith the whole question of the chromosome mechanism associated with such types of mutant. In Œnothera, relatively few mutants are found with fourteen chromosomes; these may be accounted for in terms either of crossing over or of double "non-disjunction." "Non-disjunction" has been called in to explain the existence of the relatively frequent trisomic mutations (with 15 or 16 chromosomes). It is assumed that on segregation two chromosomes of a pair, instead of separating to different gametes, both go into one cell; thus in a pollen tetrad two pollen grains will be found with eight chromosomes each instead of seven. When, as in the mutation now described by Prof. Gates, two precisely similar mutants appear in a small culture, it would seem probable that both such pollen grains have functioned, so that the male parent is responsible for the extra pair of chromosomes. Inevitably in discussing such a problem the question arises as to what extent the seven pairs of chromosomes in Œnothera may be regarded as individually distinct. Prof. Gates discusses the question in a tentative manner, directing attention to recent statements by Hance (1918) and Van Overeem (1922), who conclude that these seven pairs are distinct and form a graded series. Prof. Gates is evidently of opinion that this conclusion is not yet sufficiently soundly based upon observation and experiment, but that the cytological complexities of the problem well deserve further exploration.

Distribution of Herring Shoals.—The report of the Dove Marine Laboratory, Cullercoats, for 1922–23 contains an interesting paper by Mr. B. Storrow on the distribution of herring shoals. Evidence is given in favour of the view that the failure of the industry in 1921 was due, in part, to a migration of young North Sea herrings in the preceding winter. Late in 1920 these fish divided into two sections, one of which migrated northwards towards the Orkneys and Shetland, and the other southwards. The northern group thereby passed into an area favourable to growth, and grew rapidly. The southern section grew much less rapidly. If this be so, the herring industry in any particular locality should depend upon whether the herring caught are migrants from a region of rapid or of slow growth, rather than upon the existence of a particular year class. The author is inclined to the view that migrations, which may in some cases depend upon the "activity" of Atlantic

water, prohibit the existence of different herring races in the North Sea.

EUCALYPTUS OILS AS GERMICIDES.—Messrs. A. R. Penfold and R. Grant give an account of an investigation of the germicidal values, determined as Rideal-Walker carbolic acid coefficients, of the principal commercial eucalyptus oils and of their active constituents (Journ. and Proc. Roy. Soc. of N.S. Wales, vol. lvii., 1923, p. 80). Standard suspensions of 1 per cent. of the crude oils and their pure constituents were made in 7½ per cent. resin soap solution. Of the oils of ten species of Eucalyptus, that of *E. radiata* was the strongest and gave a coefficient of 10-12, the active principle being piperitol. Of active principles, australol, geraniol, citral, and piperitol gave coefficients of 22·5, 21, 19·5, and 13 respectively. The interesting observation is made that a lower coefficient is given by the dilution (with water) of a concentrated preparation than by a dilute preparation of the same strength, probably because the dilution of a concentrated emulsion upsets the emulsion.

RED DISCOLORATION ON DRIED SALTED FISH.—The condition known as "pink" is one to which dried salted fish is liable, and is characterised by the appearance of pink patches on the surface. It is dealt with in Special Report No. 18 of the Food Investigation Board by Dr. P. C. Cloake. These pink patches are caused by the growth of chromogenic micro-organisms of at least two species—one a red sarcina, the other a curiously polymorphic form which may be a bacillus. These organisms may be cultivated on such media as salted fish agar, provided they contain a high percentage of salt, *e.g.* 15 per cent., at a temperature of 24° C. The source of these organisms has been traced to the salt used in curing when this is of marine origin; rock salt seems to be free from them. Sterilisation of the salt at 120° C. for 30 minutes suffices to destroy the organisms.

A SUGGESTED INDICATOR FOR PETROLEUM.—In the Journal of the Royal Society of Western Australia, vol. 9, p. 8 (1923), A. Farquharson describes an occurrence of the hydrocarbon impsonite, infilling the vesicles of a basalt that underlies a limestone variously regarded as of Cambrian or Lower Carboniferous age. Specimens have been collected from various points in the Ord Valley near Kimberley, West Australia, and these were sent to the office of the Geological Survey in the first instance as possibly oil-bearing shales. The author points out that the occurrence is of sufficient magnitude to have a bearing on the search for petroleum in the district. We need not share his view (p. 17) that oil would be unlikely to occur if the rocks were of Cambrian age, since seepage from a distance is always possible, and the highly vesicular character of the basalt may have provided a favourable storehouse on the way. As E. H. Cunningham Craig remarks, migrating petroleum will make its appearance in "the most porous rock available."

CLIMATIC CHANGES AND WEATHER NORMALS.—The U.S. *Monthly Weather Review* for August contains an article by Prof. C. F. Marvin, Chief of the U.S. Weather Bureau, on the above subject. The discussion is introduced by a question, "Is the climate changing?" and justifies the answer of "Yes" or "No" to this inquiry. Geological records are said to leave no question as to the great changes the vast lapse of time has occasioned in the past, while there is said to be no conclusive evidence of notable permanent changes during thousands of years of human history. The author believes that long-time fluctuations of climatic conditions have occurred, and that minor surgings of the seasons to and fro take place for such periods as 50 to 100 years. Reference is made to the somewhat general deep-seated conviction that, to many, weather conditions at the present time differ from corresponding conditions within their memory. The prime object of the discussion is to establish a method of completing a broken record of observations, say of temperature or rainfall, so as to lengthen out to the utmost a series of observations and thus to secure long-period normals of observations to aid in obtaining proof of secular changes if such are obtainable. A method is suggested for completing the individual values for missing years which is practically a system of drawing lots from the values of all the years for which observations exist, and so on for all the years for which means are required. This system scarcely seems likely to commend itself to all workers. Considerable importance is attached by the author to the use of accumulated sums of departures from a normal base and exhibiting the same as a graph.

PHOTOELECTRIC CELLS FOR MEASUREMENTS OF TIME.—In the *Comptes rendus* of the Paris Academy of Sciences, November 5, 1923, Messrs. G. Ferrie, R. Jouart, and K. Mesny describe methods employed to amplify the current from a photoelectric cell, so that the amplified current can be used to record the passage of a pendulum through a certain point of its path. The anode of the photoelectric cell was joined to the grid of a special triode valve, and the filament of the valve to the positive of a battery, the negative of which was connected to the deposit of alkali metal in the cell; a constant high potential difference was applied between the anode plate and the filament of the valve. When the cell was illuminated, the grid was charged negatively, and the current of the valve was diminished. In this way a variation of current, 10,000 times as great as the original photoelectric current, can be obtained; and, by attaching to a pendulum a screen, provided with a slit, through which light from an electric lamp can pass, measurements of the time of vibration can be made with considerable accuracy. With a more complicated arrangement of valves, an amplification of the order 10^6 was obtained and it was possible to determine the period of the pendulum within one-thousandth of a second. The authors hope to be able to adapt the method for recording the passage of stars across the central line of a meridian telescope.

VELOCITY DISTRIBUTION OF ELECTRONS FROM INCANDESCENT OXIDES.—The velocity distribution of the electrons ejected from incandescent substances has been investigated by the integral method, not attempting to separate out the electrons moving at or near a definite velocity, but deducing the distribution law from observations which included all the different velocities present; Richardson used also the differential method. All the observers have found that Maxwell's probability law for the distribution of the velocities is correct in the case only of clean metal surfaces. In the *Zeitschrift für Physik*, November 15, 1923, Herr M. Rössiger describes experiments, using the differential method, in which the electrons pass through a longitudinal slit, parallel to the axis of the cylindrical anode; this is coaxial with a straight, incandescent platinum wire which forms the cathode and is coated with oxides of calcium, barium, or strontium. There is an outer cylinder, coaxial with the first, and electrically connected with

it; in this is a slit, parallel to that in the surface of the inner cylinder, while outside this slit, and insulated from the cylinder, is a collecting plate, which receives the electrons which pass through both slits. The inner cylinder can be rotated about its axis; so that the angle ϕ between the planes passing through either slit and the cathode wire can be varied, and measured by means of a reflecting mirror. A solenoid is wound round the cylindrical glass containing vessel, so that a magnetic field can be produced in the direction of the axis of the cylinders, deflecting electrons with a certain velocity which pass through the first slit, so that they pass through the second when ϕ has the correct value. Maxwell's law is still found to hold.

Magnetic Survey of the Balkans.—Heft 10, Bd. 131, Abt. IIa, Math. Nat. Kl. of the Sitzungsberichte of the Vienna Akademie der Wissenschaften contains a paper by Mr. A. Schedler, which gives the results of a magnetic survey carried out during 1918 in the Balkans. Results are given for 27 stations, varying in latitude from 44° 49′ to 40° 55′ N., and in longitude from 18° 32′ to 21° 55′ E. Attached to the paper are six charts. The first and the last indicate the geographical positions of the stations, and the geological features of a magnetically disturbed region. The four intermediate charts give curves of equal values of magnetic declination, inclination, horizontal force, and total force respectively for the epoch January 1, 1918. Through an oversight, the values of the force are printed as angles in the charts. For example, 0·4444 C.G.S. is printed as 44° 44′. It is interesting to note that the dip observations were taken with an English dip circle, Dover No. 1.

Inverted Flight in Aeroplanes.—A paper of considerable interest to practical aviators, as well as to workers in the dynamics of aeroplane flight, was read recently before the Royal Aeronautical Society by Squadron Leader R. M. Hill. The paper is entitled "The Manœuvres of Inverted Flight," and is based upon extensive experimental flights executed by Mr. Hill and others. The object of the experiments was threefold. The immediate aim was to examine the causes of fatal accidents that often occur in aerobatics on an unstable aeroplane, when the aeroplane assumes an inverted position and the pilot fails to right the machine. Subsidiary aims were to find the magnitudes of the loads in inverted flight, and to examine the behaviour in inverted flight of machines with different stability characteristics. An account is given of the ways in which inverted flight can be obtained, namely, by means of the half loop and the half roll, and details of the manœuvres are given for particular aeroplanes, such as the Sopwith "Camel," the "Camel" modified so as to increase its longitudinal stability, the "Snipe," the "Bat Bantam," and the S.E.5A. The use of the controls in inverted flight and the return to normal flight are similarly discussed. Mr. Hill considers the belting arrangements to be of supreme importance, especially in unstable fighting machines; pilots often fail to use the controls because they cannot reach them. Steady inverted flight is possible on all types of machines investigated; but whereas the longitudinally stable machine tends to right itself, the longitudinally unstable machine has no such self-righting properties: there is, however, no real difficulty in recovering from the inverted flight. The longitudinally unstable machine is also liable to get into an inverted spin, but here again the pilot can recover if he knows the use of the controls in such positions. Inverted loops were also investigated. Mr. Hill suggests that "the best compromise between safety and extreme manœuvrability is to be found in an aeroplane which, though preferably stable throughout the major part of its range of flying speeds with elevators free, must definitely be stable with them fixed."

Silicate of Soda for the Treatment of Concrete Roads.—Silicate of soda is now being more and more used in Great Britain for the surface treatment of concrete, following on the extensive and very satisfactory experience recorded in America. In fact, new uses for silica of soda are being found almost every day, and this material looks like rivalling sulphuric acid, soap, or soda ash as a ready test, according to the amount consumed, for the civilisation of a community. The chemical reactions that result from the application of a dilute solution of silicate of soda to concrete, say the surface of a road, are very complicated, but seem to include the combination of the silicate with the free hydrated lime liberated in the setting of cement to give a lime silicate, which forms a hard compound. At any rate, the nett result is the formation of an intensely hard outer skin—in which all the pores have been completely filled up—strongly resistant to abrasion and dusting, and largely waterproof. It is essential, however, that the silicate of soda be sprayed over the road in the form of a very dilute solution, say 1 of the liquid neutral silicate to 4 of water, whilst the silicate of soda must be prepared for the specific purpose, with a fairly high ratio of silicate to soda. As is well known, very many grades are supplied, from a low-ratio product containing 1·60 molecules silica to 1·00 molecules soda (Na_2O) to a very high-ratio grade with over 4·0 molecules silica. The right brand to use is a matter of experience and research on the part of the firms supplying the product, but the results, under proper conditions, are remarkable, and constitute a factor of national importance in the upkeep of roads.

Tests on Boiler Material.—The annual memorandum by Mr. C. E. Stromeyer, Chief Engineer to the Manchester Steam Users' Association, covering the year 1922, contains several interesting matters. Tests have been made on the material of some old wrought-iron boilers, one of which was sixty-nine years old, and a comparison with the tests of the original material shows that wrought iron does not lose tenacity appreciably with age. The furnace plates show a reduction of ductility, but not of tenacity. Mr. Stromeyer again directs attention to the effect of nitrogen on mild steel, and urges that the effect of a high proportion of this element, such as is found in Bessemer steel, requires more thorough investigation. A table of failures of mild-steel plates, bolts, stays, and rivets is given, 22 in number, and in every case the sum of $5N+P$ is greater than 0·08 per cent., the upper limit previously fixed by the author. A case for inquiry has been made out, and it is to be desired that analyses for nitrogen should be made more frequently, until its alleged harmfulness has been confirmed or disproved. The tests on riveted joints in old boilers show that the strength of a double-riveted seam in a boiler is greater than that found when the seam is cut out and the joint tested in a machine, so that the engineering practice of crediting the joints with their full strength is justified. An interesting section on dished and flat-end plates of boilers deals with the behaviour of cracks, which in some cases do not spread, but relieve the stress, so that some boilers mentioned worked for years in a cracked condition. This is traced to a very finely laminated structure in the outer layers of the plates.

The Jubilee Celebrations of the French Physical Society.

It was in 1873 that the Société Française de Physique came into being, and the first volume of the Proceedings of the Society contains a report by Lissajous on the preliminary steps that were taken. The statutes include one by which any discussion "étrangère à la physique" is prohibited. Whether the French physicist of fifty years ago was a keen politician we do not know, but it seems to have been desirable to provide against extraneous matters more rigorously than is our wont in Great Britain.

A glance at the first list of members reveals a number of very well-known names, such as the Becquerels, Berthelot, Bouty, Cornu, Jamin, Joubert, Koenig, Lippmann, Lissajous, Mascart, Sainte-Claire Deville, and Violle. The first president was Fizeau, and the following eight successive presidents were Bertin, Jamin, Quet, E. Becquerel, Blavier, Berthelot, Mascart, and Cornu. The first honorary member was the elder Becquerel. In 1876 there were five honorary members, including Regnault and Sir William Thomson; and in 1878 the names of Fizeau and Joule were added.

In the early part of this month, the founding of the Society was celebrated by a number of meetings. Apart from these there has been the Exhibition, which has hitherto been held by the Society at Easter, but has this year been combined with a Wireless Exhibition. It has been on an unusually large scale, as may be realised when it is said that the Grand Palais in the Champs Élysées, in which the annual Automobile Show is held, was used for the purpose. The Exhibition was excellent from many points of view, and was characterised by many demonstrations, more or less popular, which were very attractive.

The anniversary lectures were given at the Sorbonne, the first on Saturday, December 8, by Col. Robert, on the relations of physical and technical aeronautics.

On Monday morning, December 10, an attraction of another kind presented itself in the general meeting of the International Union of Physics. The chair was taken by M. Brillouin with Prof. H. Abraham as general secretary. The business was largely formal, the main item being the adoption of the statutes. After some discussion as to whether the value of the franc for the contributing countries should be taken in the French or Swiss currency, the former was adopted, notwithstanding the reduction in the contributions by so doing. The date of the next meeting of the Union was fixed for the year 1925, the normal three years' interval being reduced, and the question of an international congress will then be decided. A somewhat pious resolution was adopted on the desirability of authors supplying abstracts to their papers, such abstracts being left in the hands of the editor of the journal concerned for final revision. The meeting was followed by a luncheon.

On Monday evening a lecture was given by Prof. H. A. Lorentz on the old and new mechanics. The motion resulting from the impact of two balls was considered, and generalised equations were obtained which were applicable to two observers in relative motion. This was followed by the gravitational deflexion of light, and a discussion of the quantum theory and kindred subjects. The address was a model of lucidity, and at its conclusion Prof. Lorentz received quite an ovation from a crowded audience.

On Tuesday, December 11, Lord Rayleigh gave an interesting account of his investigations on iridescent colours in Nature. He dealt successively with the colours observed in light reflected from potassium chlorate crystals, mother-of-pearl, Labrador felspar, and scarabee. This work was described recently in a series of papers read before the Royal Society.

At the conclusion of the lecture Prof. Volterra presented, on the behalf of the Accademia dei Lincei, two volumes of the collected works of Volta. Other volumes are in preparation.

Wednesday, December 12, was marked by a banquet at which the delegates were royally entertained. The chair was occupied by the Under Secretary of State for Public Instruction. M. Picard (president of the Société Française de Physique) welcomed the foreign delegates, and responses were made by Prof. Volterra, Prof. Lorentz, Lord Rayleigh, Prof. Stormer, and Prof. Knudsen.

The culminating point in the celebrations came on Thursday afternoon, when the chair was taken by the President of the Republic in the large amphitheatre of the Sorbonne. There were also present the Ministers of Commerce, of Public Instruction, and of Public Works. After speeches by M. Picard and M. Brylinski (president of the French Electrotechnical Committee), Prof. Lorentz presented the addresses which had been brought by the delegates. These were numerous, and, in the alphabetical order of the countries from which they came, were from the following societies: L'Académie Royale de Belgique, La Société Scientifique de Bruxelles, L'Académie Royale de Danemark, L'Institut d'Égypte, L'Académie des Sciences de Madrid, Bureau of Standards, Carnegie Institution of Washington, L'Académie des Sciences de Finland, Royal Society, Royal Institution, Physical Society of London, Röntgen Society, Accademia dei Lincei, Accademia di Torino, La Section de Physique du Conseil National de Recherches du Japon, Le Ministère de l'Instruction Publique du Grand Duché de Luxembourg, La Société de Physique de Christiania, L'Académie Royale des Sciences d'Amsterdam, La Société Hollandaise des Sciences de Haarlem, L'Académie de Cracovie, La Société Polonaise de Physique, La Société Suisse de Physique, La Société de Physique et d'Histoire Naturelle de Genève, La Société Zurichoise de Physique et l'École Polytechnique fédérale de l'Université de Zurich, L'Union des Mathématiciens et des Physiciens tchecoslovaques à Prague.

After this part of the ceremony came a speech by M. Bérard (Minister of Public Instruction), followed by remarks by the President of the Republic. The latter with his ministers then withdrew, and we settled down to a discourse by Prof. C. Fabry on the domain of radiations. The programme was interspersed throughout by a selection of music rendered by the celebrated band of the Garde Républicaine.

The magnificent amphitheatre of the Sorbonne, in which these proceedings were held, seats about 3000 people, and gave rise to some reflections, possibly not only on the part of the present writer. Where is such a theatre to be found among our educational institutions in London? Unfortunately, nowhere; and if we had such a theatre, would an audience of, say, 2500 people come on such an occasion, and listen to an address (unillustrated) on the difficulties experienced in exploring the field of radiation, from the longest waves, as used in wireless telegraphy, to the shortest, as shown by X-rays? We doubt it, even if the Prince of Wales were present. The value of science is obviously recognised more fully in Paris than in London.

Lectures by Prof. Störmer on the aurora borealis on Friday, December 14, and by Prof. Knudsen on the mechanism of evaporation and condensation, on Saturday, brought to a close these very interesting and very successful celebrations.

Virus Diseases of Plants.

AN interesting discussion upon "Virus Diseases of Plants" was held during the meeting of the British Association at Liverpool between the Sections of Botany and Agriculture. These obscure maladies, which are of great economic importance, affect a great variety of cultivated plants and have lately received much attention from plant pathologists. Formerly these diseases were attributed to general physiological degradation, notably in the potato, but since they have been shown to be markedly infectious, they are usually considered to be caused by organisms of ultramicroscopic size, which are disseminated largely by means of insects.

The discussion was opened by Dr. Paul Murphy, who first described the symptoms of these diseases in general and compared them briefly with certain diseases of animals of somewhat similar type. He then dealt specifically with the "leaf-roll" and "mosaic" diseases of potatoes, both of which cause enormous losses in yield. In discussing "leaf-roll" of potatoes, Dr. Murphy maintained that the abnormal accumulation of starch in the leaves, which led to rolling, preceded the degeneration of the phloem, which is also a marked symptom of this disease. In potato "mosaic," characterised first by a mottling of the foliage and later by marked degradation of the whole plant, he stated that this disease sometimes masked other "virus" diseases of the potato such as "stipple-streak" and "crinkle." He had also demonstrated that certain varieties might act as "carriers" of this disease, in which the symptoms remained dormant, although infection could still be spread from these plants. As instancing the rapidity with which degeneration caused by such diseases might occur, Dr. Murphy said that on a farm at Ottawa potatoes had been grown healthily for seventeen years, but that, after this period, marked degeneration set in during the course of a single season, which had affected all potatoes subsequently grown on that farm. He considered, however, that there still remained a certain reduction in yield attributable to non-pathogenic causes when the same healthy stock was grown in different but apparently suitable localities.

Prof. H. M. Quanjer, of Wageningen, Holland, who has made a special study of these diseases in the potato, then gave an account of his own researches on these maladies. In regard to "leaf-roll" he combated the view of Dr. Murphy that the seat of the disturbance lay in the abnormal accumulation of starch in the leaves, maintaining that the primary effect of disease was the necrosis of the phloem consequent upon the entry of the "virus" through insect agency. He pointed out that infection by aphides during May and June first resulted in rolling of the upper leaves during August. Prof. Quanjer claimed that the real seat of these "virus" diseases was the phloem, and suggested therefore that they should be called "phloem diseases" rather than "virus" diseases, although he admitted there was no visible degeneration of the phloem in "mosaic" diseases. In this connexion also it must be conceded that there are other diseases of phloem tissues which do not fall into the category of "virus" diseases. Prof. Quanjer emphasised the rôle played by insects, especially aphides, in the dissemination of these diseases, but pointed out that in some "mosaic" diseases transmission was possible through mechanical abrasion of the leaf hairs.

Dr. W. B. Brierley exhibited lantern slides which showed in a striking manner, by reference to American statistics, the losses caused by these diseases in crop plants. With regard to sugar-cane "mosaic," he stated that varieties resistant to the disease had recently been discovered which would probably prove the salvation of the cane industry in certain districts.

Mr. T. Whitehead classified "virus" plant diseases into four categories, of which the following are examples:

(1) Infectious chlorosis, which is transmissible only by grafting.

(2) Spike disease of the sandal-wood tree, in which there is neither abnormal starch accumulation nor phloem necrosis.

(3) Leaf-roll of potatoes, in which abnormal starch accumulation accompanies phloem necrosis. This disease is transmissible by insects, but not by expressed sap alone.

(4) Potato mosaic, in which there is neither accumulation of starch nor phloem necrosis, although the sugar content may be unusually high.

This disease is transmissible by the sap alone, without insect agency. Mr. Whitehead appealed for more accurate methods in diagnosing this group of diseases, and gave striking evidence for the transmission of potato "leaf-roll" through the soil. He suggested that these diseases could be best controlled by raising resistant varieties and by establishing special beds of potatoes for seed purposes, which could be rogued effectively and lifted early.

Mr. Holmes Smith expressed the view that leaf-roll was by far the most serious of the "virus" diseases of the potato in this country. Unfortunately manurial treatment had no effect upon it, although this was somewhat beneficial in potato mosaic.

Dr. R. N. Salaman pointed out that although this year he had taken the trouble to spray his seedling potatoes, planted in old garden soil, with nicotine at frequent intervals in order to control aphides, infection by mosaic and leaf-roll had been more serious than ever before, although seedlings planted in remote plots in other crops had remained healthy. *Solanum nigrum* appeared to be of no importance as a "carrier" of these diseases. Dr. Salaman expressed the view that "virus" diseases of the potato were probably not congenital, and that susceptibility to leaf-roll was transmitted independently of susceptibility to mosaic disease.

F. T. BROOKS.

Australian Railway Development: a Study in Political Geography.

MR. O. H. T. RISHBETH read a paper on this subject to Section E (Geography) of the British Association at Liverpool. Railway systems typify the humanised as opposed to the purely physical environment, and in so far as they reflect the higher social and political mentality of the people, contribute most useful data for the human geographer. In Europe the system of national states, with their semi-geographical basis, was evolved before the railway era. The railway systems superimposed on a well-defined national background share the intense individualisation of the continent. Europeans brought to Australia this tradition of individualism and exclusiveness.

Mr. Rishbeth maintained that Australia is a clear-cut geographical unity and that its interstate bound-

aries are mathematical and artificial: with one or two exceptions they have no geographical meaning. The early settlements around the island-continent were separated by long stretches of inhospitable coast and still more difficult interior. From these various centres the human settlement developed on old-world lines. This is expressed in the various state railway systems, each planned without reference to those of adjoining states.

The geographical and economic unity of the island was overlooked until a much later date, but the commonwealth feeling or spirit is now making rapid headway and is reflected in the new and newly planned railway lines. These lines are projected to bind together and not to separate the various states. All major Australian railway schemes are essentially commonwealth propositions in that they involve the interests of more than one state. A sketch map was shown to indicate the economic areas, independent of political divisions, which may be regarded as the hinterlands of different stretches of sea coast. On this map it is possible to forecast, with tolerable certainty, the main outlines of the completed Australian railway system. Briefly, this entails an outer ring of which the elements already exist; an inner circle; fragments of a radial system cutting across both circles and joining hinterlands with their appropriate ports; certain overland lines from north to south and east to west. These systems when fully built will unify the continent and overrule the artificiality of the original states.

Structure of Greenland.

We have recently received, though the work is dated 1920, volume 53 of the "Neue Denkschriften der Schweizerischen Naturforschenden Gesellschaft,"[1] containing an account of the Swiss trans-Greenland Expedition of 1912–13. Between southern Greenland at about lat. 64°, where the country was crossed by Nansen in 1888, and Peary's routes of 1892–95 through 80° N., the interior of Greenland remained unknown for an interval of more than 1000 miles. In order to determine the structure along one line through this gap a Swiss expedition under Prof. de Quervain in 1912 traversed Greenland from the western coast in lat. 69° 46′ opposite Disko to the eastern coast in lat. 66°. The journey on the inland ice was begun on June 20. The summit of the ice-cap was crossed on July 8, and its eastern margin was reached on July 21. The party, with dog-drawn sledges, averaged 22 kilometres a day. Meanwhile the western party under Prof. Mercanton investigated the open country on the western edge of the ice-cap to the east of Disko Island.

The new traverse of Greenland confirms the general accuracy of Nansen's profile, though, as he crossed the country where the ice-cap is narrower but rises to a greater height, his gradients were steeper than those found by the Swiss party. Doubt is thrown as to the distance inland reached by von Nordenskjöld in 1883. The expedition, however, supports his view that cryoconite consists in part of meteoritic material. Nordenskjöld's conclusion has generally been rejected and the material explained as dust blown on to the ice from the nearest rocks. Part of the cryoconite collected by the Swiss expedition is regarded as derived from local diorite, but it contains spherules of magnetite which Prof. Mercanton regards as possibly of extra-terrestrial origin. In this view he supports the conclusions of Wulfing and of Swinne (1919). In the absence, however, of proved nickel, the meteoritic origin of the magnetite may still be regarded as open to doubt.

The western party made careful measurements of the ice movements, and found it to vary from less than a centimetre a day on the ice front to 2½ metres. It is shown that the bare land in west-central Greenland was once covered by the ice-sheet, and Prof. Mercanton supports the view that, with the exception of some of the high southern mountains, the whole of Greenland was once buried under an ice-cap. His account and photographs show the powerful disruptive effect of frost on bare rocks in the neighbourhood of ice. The larger part of the volume is occupied by the meteorological observations and results, including the records of some pilot-balloons.

The last chapter describes the collection of Eskimo skulls, and its author, Dr. Hoessly, rejects the view that the Eskimo reached Greenland from Europe across the Faroes and Iceland; he regards the Eskimo as the most primitive section of the Mongolian race. The volume is well illustrated by four plates of maps and sections, nine plates, and numerous figures in the text.

[1] "Neue Denkschriften der Schweizerischen Naturforschenden Gesellschaft" (Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles) Band 53. Pp. xx + 402 + 54. (Basel, Genf und Lyon: Georg und Co., 1920.)

Building Materials made of Waste Materials.[1]

By Prof. A. P. Laurie.

We have in Great Britain large accumulations of blast furnace slag, of cinders, and clinker, and in the neighbourhood of Edinburgh of burnt shale, the residue from the stills of the oil industry. There are three ways in which these materials can be utilised—for the production of bricks, for the production of cement, and as aggregate mixed with Portland cement or plaster of Paris. The general method adopted for the production of bricks is known as the sand lime process. Briefly, this process consists of mixing the aggregate with a certain proportion of lime and water, squeezing it into a brick under a pressure of some two hundred tons to the area of the brick and then steaming under high pressure or in open steaming chambers. Bricks are now being manufactured by this process from sand, blast furnace slag, granulated by being run while hot into water, clinker, town refuse, slate dust, and burnt shale.

Cement is being manufactured by two of the Scottish steel companies from blast furnace slag granulated, mixed with lime, and then raised to a high temperature so as to form a clinker in the same way as ordinary Portland cement was manufactured. This cement, known in Germany as iron cement, can be sold in this condition, or can be finally ground with a mixture of a certain proportion of raw blast furnace slag.

The uses of these materials as an aggregate opens the question of how far it is possible to reduce the content of Portland cement and, at the same time, get sufficient strength for building purposes. The objection to the usual building slab made of cement is that, in order to be able to remove it from the machine as soon as made, the content of water has to be kept low and, consequently, the crushing strength of the finished slab is also low. Two interesting methods of getting over this difficulty are the Crozite method, in which the cement bricks were sliced off from the bottom of a column of cement and aggregate, and the method used by the Triangular Construction Company, in which a heavy compression is put upon the bottom and top of the slab at the

[1] Substance of a lecture delivered at the Royal Academy of Arts, London, on Wednesday, November 21.

moment of completion. It has been possible in the case of the slabs made by the Triangular Construction Company to reduce the amount of cement to one to twelve of aggregate, and the manufacture of cement bricks by the Crozite process is being carried on in a large scale in America.

Many waste products such as sawdust, disintegrated wood, and ordinary cheap aggregates such as clinker can be utilised in slabs made from plaster of Paris. There are large and easily available deposits of gypsum in Great Britain, but the industry has never been developed on the enormous scale found in America, where all kinds of materials required by the builder have been turned out made from plaster of Paris as the cement.

University and Educational Intelligence.

THE *University Bulletin* issued by the Association of University Teachers has hitherto been confined mainly to a record of the activities of the Association, which have been concerned largely with questions of remuneration and other conditions of tenure of university posts. In the November issue an effort is made to widen its circle of readers. Lord Gorell contributes an article dealing with three subjects: (1) expected developments of the functions of the Teachers' Registration Council with the view of the establishment of teaching as one of the unified learned professions; (2) the financial needs of universities; and (3) the projected Imperial Education Bureau. Prof. Arthur Thomson's thoughtful and arresting essay on the essentials of education deserves a wider circulation than the *Bulletin* can hope to give it. Here is a biologist dealing with the ignorance of young Scotland as faithfully as Prof. Burnet in his Romanes lecture dealt with the same subject from the point of view of the humanist. Over the familiar initials M. E. S. appears a plea for large capital grants to universities as recommended by the Royal Commission of 1870 on Scientific Instruction and the Advancement of Science. Prof. Sandbach tells of a committee having been appointed by the A.U.T. to consider and report on the subject of co-operation between libraries, possibly on the lines of the German central information bureau and general card catalogue, for the benefit of research workers in Great Britain and Ireland. There is also a contribution from Melbourne on the perils of inbreeding and localism in universities in the Overseas Dominions.

THE North of Scotland and the Edinburgh and East of Scotland Colleges of Agriculture append to their calendars for 1923–24 lists of appointments gained by their students. They illustrate the Scottish propensity, referred to in Mr. Rudyard Kipling's recent rectorial address, for "raiding the world in all departments of life—and government." The lists include posts in England (53), Canada, the United States, South America, the West Indies, Australia, New Zealand, South, West, East, and Central Africa, the Sudan, Egypt, Cyprus, Hungary, India, Burma, Ceylon, Straits Settlements, Malay States, Java, Sumatra, Borneo, Fiji, and Hawaii: only 60 out of the 280 were in Scotland. The director of studies of the North of Scotland College reports that in 1922–23 a record number of students (27) obtained the degree in agriculture. Both colleges do a large amount of "county extension" work in addition to the instruction and research carried on at their headquarters and at college and experimental stations. The northern college report records 67,096 attendances and 2929 classes and lecture meetings and 11,840 visits to farms and crofts for instruction and advice. A scheme of rural science to be taught in conjunction with school gardening was introduced into several schools and proved efficacious "in creating an interest in school gardening which is lacking at present."

RHODES Scholars in residence at Oxford in 1922–23 numbered 273, namely, 125 from the British Empire and 148 from the United States. Of these, 57 were taking natural science and medicine, 10 economics, and 6 mathematics. Sixty-eight Rhodes scholars were successful in the final honour schools examinations, namely, first class 14 (United States 8, Canada 2, Australia 2, New Zealand 1, South Africa 1); second class 31 (United States 16, others 15); third and fourth classes 23 (United States 11, others 12). The Ph.D. degree was awarded to 7 (all from the United States), the B.Sc. or B.Litt. to 17, and the B.C.L. to 18. Among other academic distinctions obtained by Rhodes scholars may be mentioned the Christopher Welch scholarship in biology and the James Hall Foundation essay prize, both won by Americans, the Francis Gotch memorial prize won by a scholar from New Brunswick, the David Syme research prize (Melbourne) won by a scholar from Victoria, the Bourse des Œuvres françaises à l'étranger (tenable for one year in a university in France) awarded to a New South Wales scholar, two demonstratorships and a tutorial fellowship at Oxford awarded to two Australians and a South African, and a Rockefeller Medical research fellowship, tenable in the United States, to which an Australian scholar was elected. In athletics distinctions were won by 11 scholars from the United States, 10 from Australasia, 6 from Canada, and 4 from South Africa.

A NOTABLE citizen of Bolton, Lancashire, Mr. J. P. Thomasson, made known to the School Board of the Borough in 1876 his intention to allot the sum of 750*l.* annually for a period of ten years, in order to assist scholars from the elementary schools to proceed to higher schools before becoming pupil teachers. His purpose was to secure a body of teachers in elementary schools efficiently educated and properly trained for their duties. The School Board felt that the full benefit to be derived from the scholarships would not be realised if they were restricted to those entering upon the profession of teacher, and Mr. Thomasson consented to enlarge the scope of the scheme so as to encourage pupils from the elementary schools to continue their education at higher schools and to encourage suitable pupils to become teachers. The scheme provided fees, books, railway fares, and a grant towards maintenance. Mr. Thomasson died in 1904, and Mrs. Thomasson intimated her willingness to continue the benefaction for a further period. Meantime the School Board ceased to act and the Town Council became the Education Authority. The scheme was enlarged in its scope, and provision was made for scholarships for boys and girls between 16 and 17 years of age who had been in attendance at secondary schools in Bolton to continue their education in such schools, for leaving scholarships of the annual value of 150*l.* tenable for three years at a university and for a post-graduate scholarship at a foreign university of the annual value of 200*l.* tenable for two years. The scheme has now come to an end. During the 46 years of its existence under varying conditions there have been awarded 122 major exhibitions, 427 minor scholarships, 36 scholarships in respect of continued education at secondary schools, 18 university scholarships, and one post-graduate scholarship. The total sum received from Mr. and Mrs. Thomasson amounts to 26,438*l.*, and the examination expenses, etc., to only 1718*l.* during the whole period, testifying to the fact that the scheme has been most economically administered.

Societies and Academies.

LONDON.

Geological Society, December 5.—Prof. A. C. Seward, president; and, afterwards, Dr. G. T. Prior, in the chair.—The following communications were read: C. W. **Osman**: The geology of the northern border of Dartmoor, between Whiddon Down and Butterdon Down. The Lower Carboniferous rocks may be divided into a Lower Aluminous and a Calcareous Series. The latter commences with grey shales above the Lower Aluminous series, without any physical feature, and contains a volcanic band, generally in a fragmentary condition, mixed with ash, slate, and other fragments, and impregnated with chert; but, at East Underdown, the rock is more solid, and is a quartzless keratophyre. The corresponding mixed igneous rocks of the north-western Dartmoor border, which have been variously described, are altered keratophyres. Above the volcanic band are two limestone-areas: one on the west, near Whiddon Down, and, separated by quartzose rocks, another limestone-area at Drewsteignton. Throughout the length of border considered, the top of the Calcareous Series is formed of grey shales, with hard rock-bands which pass upwards into the Upper Aluminous Series. The granite south of the Carboniferous border-rocks shows three separate intrusions, all from the same magma, but showing sufficient differences to separate them.—D. J. **Farquharson**: The geology of southern Guernsey. With the possible exception of some dykes of doubtful Palæozoic age, the whole of Guernsey consists of pre-Cambrian rocks—gneisses and schists in the south; unfossiliferous shales and grits at Pleinmont; and a series of intrusions in the north, which range from hornblende-gabbro through diorites and tonalites to granites with their accompanying dykes. These dykes not only pierce the last-named suite, but also the gneisses and grits of the south.

PARIS.

Academy of Sciences, November 26.—M. Albin Haller in the chair.—E. L. **Bouvier**: *Ormiscodes gregatus*, a moth the larvæ of which group together to build complex pouches. A description of the building habits of a new species of Ormiscodes found by M. Grisol in the neighbourhood of San Fernando d'Apure, Venezuela. The pouch is built in common, and may contain 10 to 12 cocoons. The name *Ormiscodes gregatus* is proposed for the species.—G. **Friedel**: The black inclusions contained in Cape diamonds. These inclusions have been regarded as graphite, but without clear proof. E. Cohen has shown in a large diamond of 80 carats that the inclusion was a flattened crystal of oligist, and has concluded that many inclusions, if not all, are oligist. The author regards these conclusions as too sweeping, and shows that in the case of a diamond in the University Museum at Strasbourg the inclusion was certainly not oligist, but was very probably graphite.—M. Aimé Cotton was elected a member of the section of general physics in the place of the late J. Violle.—Harald **Bohr**: The approximation of nearly periodic functions by trigonometrical summation.—Pierre **Humbert**: The confluences of Clausen's series.—Léon **Pomey**: Linear integro-differential equations with several variables.—René **Lagrange**: Systems connected with linear differential equations.—Paul **Sonnier**: Thin rectangular plates with edges resting on a fixed surface.—Ernest **Esclangon**: Gliding flight without motive power.—C. E. **Guye**: The motion of the gas in the electromagnetic rotation of the electric discharge. In the case where the action of the positive ions is alone concerned in imparting a movement of rotation to the gas, the observed velocity V can be put in the form

$$V = \frac{\epsilon H}{12\pi\sigma^2 Mm}\left[1 + \frac{3N}{M - N}\right],$$

where ϵ is the charge of the ion supposed equal to that of the electron, H the magnetic field producing the rotation, σ and m the radius and mass of the molecule or positive ion, M the total number of molecules, ionised or not, and N the number of positive ions contained in unit volume of the discharge. This expression allows the approximate deduction of N.—R. **Mesny** and P. **David**: Very short waves in wireless telegraphy. With very short wave-lengths it is possible to utilise parabolic mirrors so as to direct the bundle of radiations. The short waves are produced by an arrangement of two symmetrical triodes: waves of wave-length of 1·6 metres can be produced, and telephonic communications have been produced with these at a distance of two kilometres without using mirrors.—Paul **Woog**: The resistance to rupture, lateral compression and equilibrium, of monomolecular layers of various substances in thin films on water.—René **Audubret**: The influence of polarisation on photo-voltaic effects. The mechanism of the phenomenon. The results of the experiments described can be expressed in terms of the Nernst theory by saying that light acts on the electrodes by modifying the solution tension of metals, with an intensity and sense connected with the state of polarisation of the plate.—J. **Pouget** and D. **Chouchak**: The radioactivity of the mineral waters of Algeria.—A. **Lassieur**: An arrangement for electrolysis with graded potentials. The method of Sand and of A. Fischer is modified by replacing the potentiometer measurement by a millivoltmeter and a high resistance.—Camille **Matignon**: A new reaction for the preparation of strontium. Strontia is heated in an iron tube with silicon and the strontium condensed in the cool part of the tube.—M. **Faillebin**: The hydrogenation of certain ketones in the presence of pure or impure platinum black.—A. **Daucet**: The action of xanthydrol on semicarbazide, the substituted semicarbazides, the semicarbazones and benzoylhydrazine. The monoxanthylsemicarbazide is shown to possess the constitution $NH_2.NH.CO.NH.CH(C_6H_7)_2O$, the hydrazine radicle remaining free and capable of combining with aldehydes and ketones in the usual manner.—P. **Gaubert**: The optical properties of graphite and graphitic oxide. The index of refraction of graphite is between 1·93 and 2·07; the crystal is optically negative.—David **Rotman-Roman**: Contributions to the lithology of the Yemen; deep rocks and non-differentiated lode-bearing rocks.—Albert **Michel-Lévy**: Some eruptive rocks from the neighbourhood of Toulon (Var).—Léon **Bertrand** and Léonce **Joleaud**: The relations between the crystalline and sedimentary formations in the western part of Madagascar, between Betsiboka and Tsiribihina.—R. **Dongier**: Magnetic measurements carried out in Dauphiné, Savoie, and Bresse.—Beaulard **de Lenaizan**: The earthquake of November 19, 1923. This shock was recorded on the barograph at Montpellier at 3.40 A.M.—Lucien **Daniel**: New researches on the migration of inulin in grafts of Compositeæ.—A. **Guilliermond**: New observations on the evolution of the chondriome in the embryonic sac of the Liliaceæ.—P. **Lecomte du Noüy**: Meaning of the maximum fall of surface tension of the blood serum.—L. **Mercier** and Raymond **Poisson**: Contribution to the study of the atrophy of the wings and muscles of flight in the Forficulidæ.—Alain **Caillas**: The composition of propolis of bees. Propolis, or bee glue, contains 70 per cent. of resins and 30 per cent. of wax.—Louis **Boutan**: The two zones of external

epithelium of the mantle and their influence on the quality of the pearls in molluscs.—L. Fage and R. Legendre: The nuptial dances of some species of Nereis.—Boris Ephrussi: The action of a high temperature on the mitosis of segmentation of the eggs of the sea urchin.—Nicola Alberto Barbieri: Presence of the retina and absence of the optic nerves in anencephalic monsters.—R. Bazin: Certain coincidences of malignant neoplasms and their delay in appearance.—E. Lesné, L. de Gennes, and Ch. O. Guillaumin: Study of phosphating in cases of rickets and its variations under the influence of ultraviolet rays.—E. Wollman and J. A. Graves: Alexic hæmolysis and proteolysis.

Cape Town.

Royal Society of South Africa, October 17.—Dr. A. Ogg, president, in the chair.—K. H. Barnard: An example of adaptation in a South African isopod Crustacean. One of the most interesting inhabitants of the empty tubes of the reef-building polychaet worm, *Sabellaria capensis*, is an isopod Crustacean, allied to Eisothistos. This animal has evolved an elongate worm-like shape in strong contrast to the other members of the Isopoda. The "tail-fan" on the other hand is greatly enlarged, and when fully expanded fits the mouth of the worm-tube exactly.—S. H. Haughton and A. W. Rogers: The volcanic rocks south of Zuurberg. In the divisions of Steytlerville, Uitenhage, and Alexandria, the rocks extend through an area about 100 miles in length from east to west along the northern boundary fault of the Cretaceous beds and are continued southwards round the western end of the Cretaceous area, following it again towards the east on its southern side for 23 miles. The folded belt of rocks belonging to the Cape system and lower part of the Karroo system forms an incomplete "frame" defined by faults on the north, west, and partly on the south, within which there is a sunken area. This area consists of Cretaceous rocks lying unconformably upon an uneven surface of marls, sandstones, sandy tuffs, breccias, and basalts. This latter post-Ecca, pre-Cretaceous formation forms a syncline of post-Uitenhage date, and is unaffected by the intense folding and cleavage of the surrounding region. It can probably be correlated with part of the Stormberg series.—A. V. Duthie: Studies in the morphology of *Selaginella pumila*. Part III. The embryo. The megaspores of *Selaginella pumila*, which are shed towards the end of the year, lie dormant on the soil during the summer months and germinate after the early winter rains. Intra-sporal embryos can endure prolonged drying without losing their vitality. The embryo has a prominent foot with large haustorial cells which project into the non-septate storage cavity of the megaspore. The cotyledons do not develop simultaneously, nor are they strictly opposite each other. The first dichotomy of the axis, which takes place at the level of the cotyledons, gives rise to two branches, one of which grows erect; the other develops into a very short horizontal rhizome with branches alternately right and left. The number of cones found on adult plants varied from 1 to 160. The sporophytes are greatly modified by conditions of environment. *S. pumila* possesses a number of characters which are very suggestive of the tree-like Lycopods of the Palæozoic. Its closest relative is the Australian species, *S. Preissiana*.—J. R. Sutton: On the genesis of diamond. The various known forms of diamond are attributable to growth only. Crystallisation was not necessarily at a high temperature, and may have been preceded by a condition of plasticity in the carbon. Diamond was deposited from a carbon solvent within cavities, the contour of which determined its final form and habit, in a solid or solidifying matrix.—J. S. v. d. Lingen: On the action of some fluorescent antiseptics in the dark. (Preliminary note.)

Brussels.

Royal Academy of Belgium, January 6.—M. Aug. Lameere in the chair.—El. and Em. Marchal: The "Homothallism" of some Ascomycetes. In cultures of single spores the following Ascomycetes produce normally fertile perithecia: *Hypocopra fimicola*, *H. macrospora*, *Sordaria tetraspora*, *Philocopra setosa*, *P. curvicolla*, *Sporormia intermedia*, *Choetomium elatum*. Hence these species should be considered as "homothallic."—V. Van Straelen and M. E. Denaeyer: The fossil eggs of the Upper Cretacean of Rognac in Provence. These fossils have been submitted to a palæontological and mineralogical study. It is not possible to determine with precision the origin of the eggs, but they present more analogies with birds' eggs than with those of reptiles.—P. Bruylants and J. Gevaert: Contribution to the study of the reaction between organo-magnesium compounds and nitriles. Vinyl-acetic nitrile. Vinyl-acetonitrile with ethylmagnesium bromide gives dipropenyl, two isomers of crotonitrile, and two polymers of the latter.—P. Bruylants: The action of organo-magnesium compounds on glutaric nitrile.

February 3.—M. Ch. J. de la Vallée-Poussin in the chair.—Clément Servais: A group of three tetrahedra.—C. de la Vallée-Poussin: The movement of a heavy homogeneous solid of revolution fixed by a point on its axis.—Th. de Donder: The physical interpretation of general relativity.—Lucien Godeaux: Cyclic involutions of fourth order belonging to a surface of genus one.

March 3.—M. Ch. J. de la Vallée-Poussin in the chair.—Th. de Donder: The physical interpretation of general relativity.—Marcel Winants: Intersecants and tangentials.—Victor Van Straelen: The systematic position of some decapod Crustacea of the Cretacean epoch.

April 7.—M. Ch. J. de la Vallée-Poussin in the chair.—Th. de Donder: Remarks on the Einstein gravific.—P. Stroobant: (1) The National Astronomical Committee. An account of the work carried out during the years 1921 and 1922. (2) National Committee of Geodesy and Geophysics. An account of the work done in 1921 and 1922.—Jean Morelle: The cytoplasmic constituents in the pancreas and their rôle in secretion.—Laure Willem: Researches on the aerial respiration of the Amphibia.

May 8.—M. Léon Fredericq in the chair.—G. Cesaro: The equiorientation and similitude of the ellipse of inertia and Steiner's ellipse in the triangle. The Steiner ellipsoids and ellipsoid of inertia of the tetrahedron.—P. Fourmarier: The presence of oolitic pebbles in the Tertiary gravels of Cokaifagne (Sart-lez-Spa).—H. Philippot: The comparison of time by wireless telegraphy in 1922. A detailed study of the results obtained over one year at the Observatories of Algiers, Edinburgh, Greenwich, and Uccle on the observations of the time signals sent daily from Paris by wireless telegraphy.

June 2.—M. Ch. J. de la Vallée-Poussin in the chair.—P. Fourmarier: The supposed glacial phenomena of the Baraque Michel. The author concludes that it is improbable that the plateau of the Baraque Michel has been covered by a glacier.—Laure Willem: Aerial respiration in the Amphibia (2).

July 7.—M. Ch. J. de la Vallée-Poussin in the chair.—Jean Massart: Researches on the lower organisms. (VIII.) Reflexes in Polyporus.—Cl. Servais: The

geometry of the triangle and the tetrahedron.—Francis **Meunier**: The electrolytic overvoltage of hydrogen. A short account of the present knowledge of the phenomena of overvoltage, with an experimental study of the overvoltage of hydrogen on platinum, lead, molybdenum, and tungsten. It has been found that the magnitude of the cathode surface is without influence, the overvoltage increasing as the concentration of the electrolyte diminishes. The fluorine ion, added in small proportions, reduces the overvoltage.—A. **d'Hooghe**: The mechanism of the reduction of oxide of zinc.

August 4.—M. Ch. de la Vallée-Poussin in the chair.—Th. **de Donder**: The fundamental formula of the new gravific.—P. **Fourmarier**: The southern extension of the gap of Theux.—Fréd. **Swarts**: The catalytic hydrogenation of organic compounds containing fluorine. Meta-trifluorcresol treated with hydrogen in the presence of platinum black gives trifluormethyl-cyclo-hexanol, trifluormethyl-cyclohexane, and water. The velocity of the reaction was studied.—Edouard **Herzen**: A simple method of obtaining the stationary orbits of Bohr in the hydrogen spectrum.—L. **Godeaux**: The cyclic involutions of the fourth order belonging to a surface of genus one (2).—G. **Lemaitre**: A property of the Hamiltonians of a multiplier.—Laure **Willem**: Researches on the aerial respiration of the Amphibia (3).

Official Publications Received.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 7, No. 3: A Preliminary Note on the Decomposition of Calcium Cyanamide in South Indian Soils. By Dr. Roland V. Norris, B. Viswanath, and C. V. Ramaswami Ayyar. Pp. 55-75. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 12 annas; 1s.

Bulletin of the American Museum of Natural History. Vol. 48, Art. 17: New Fossil Mammals from the Pliocene of Sze-Chuan, China. By W. D. Matthew and Walter Granger. Pp. 563-598. Vol. 48, Art. 18: The Problem of the Uintatherium Molars. By Horace Elmer Wood. Pp. 599-604. (New York.)

Department of Agriculture, Madras. Bulletin No. 84: A Soil Survey of the Periyar Tract. By Dr. Roland V. Norris, M. R. Ramaswami Sivan, and S. Kasinatha Ayyar. Pp. 6+10 maps. (Madras: Government Press.) 1.14 rupees.

Meteorology in Mysore for 1922: Being the Results of Observations at Bangalore, Mysore, Hassan, and Chitaldrug. Thirtieth Annual Report, by C. Seshachar. Pp. iii+15. (Bangalore: Government Press.)

Mysore Government: Meteorological Department. Report of Rainfall Registration in Mysore for 1922. By C. Seshachar. Pp. xvii+35. (Bangalore: Government Press.)

Publications of the South African Institute for Medical Research. No. 16: On the Effects of Cold on the Vitality of certain Cysticerci and Echinococci in Meat kept under Commercial Conditions of Freezing in Johannesburg. By Dr. Annie Porter. Pp. 49. (Johannesburg.) 5s.

The Indian Forest Records. Vol. 9, Part 9: Note on the Work of Extraction of Broad Gauge Sleepers from Nepal. By J. V. Collier. Pp. 349-357+15 plates. (Delhi: Government Central Press.) 1.11 rupees.

Geological Survey, Canada. Index to Separate Reports 1906–1910 and Summary Reports 1905–1916. Compiled by F. J. Nicolas. Pp. 305. (Ottawa: F. A. Acland.)

Canada. Department of Mines: Geological Survey. Summary Report, 1922, Part B. Pp. 135B. Summary Report, 1922, Part C. Pp. 91C. (Ottawa: F. A. Acland.)

Tide Levels and Datum Planes on the Pacific Coast of Canada; from Determinations by the Tidal and Current Survey up to the Year 1923. (Published by the Department of Marine and Fisheries.) Pp. 68. (Ottawa: F. A. Acland.)

Transactions of the Astronomical Observatory of Yale University. Vol. 3, Part 2: Trial of the Loomis Memorial Telescope for Stellar Photometry; with Determinations of the Light Curves of the RR Ceti ($1^h\ 27^m$) and of VV Orionis ($5^h\ 28^m$). Pp. 51-80. (New Haven.)

The South-Eastern Naturalist: Being the Twenty-eighth Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Twenty-eighth Annual Congress, held at Maidstone, 1923. Edited by Edward A. Martin. Pp. lxxxii+94+8 plates. (London.) 5s. net.

International Geodetic and Geophysical Union (Union Géodésique et Géophysique Internationale): Section of Terrestrial Magnetism and Electricity. Bulletin No. 3: Transactions of Rome Meeting, May, 1922. Edited by Louis A. Bauer. Pp. vii+181. (Baltimore, Md.: Johns Hopkins Press.) 3.50 dollars.

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 13, No. 1, December. Pp. 313. (Plymouth.) 10s. net.

Bulletin of the National Research Council. Vol. 6, Part 5, No. 36: Catalogue of Published Bibliographies in Geology, 1896–1920. Compiled by Edward B. Mathews. Pp. 228. (Washington, D.C.: National Academy of Sciences.) 2.50 dollars.

Nineteenth Report, State Entomologist of Minnesota to the Governor. By A. G. Ruggles. Pp. 151. (St. Paul, Minn.: Agricultural Experiment Station, University Farm.)

Annuaire pour l'an 1924, publié par le Bureau des Longitudes. Pp. viii+658+A9+B26+C17+D10+E26+F72. (Paris: Gauthier-Villars et Cie.) 6 francs.

Diary of Societies.

SATURDAY, DECEMBER 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir William Bragg: Concerning the Nature of Things: The Nature of Gases (Juvenile Lectures (2)).

MONDAY, DECEMBER 31.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Mrs. Charles Hose: Boat Journeys in Sarawak (Lecture for Young People).

TUESDAY, JANUARY 1.

CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College), at 2.30.—Sir W. Henry Hadow: The Claims of Scholarship (Presidential Address).

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir William Bragg: Concerning the Nature of Things: The Nature of Liquids (Juvenile Lectures (3)).

MONTESSORI SOCIETY (at University College), at 6.—Miss Barbara Low: The Value of Psycho-Analysis to the Educator.

WEDNESDAY, JANUARY 2.

ROYAL SOCIETY OF ARTS, at 3.—Prof. W. A. Bone: Fire and Explosions (Dr. Mann Juvenile Lectures (1)).

SCHOOL NATURE STUDY UNION (at University College), at 3.—Sir Richard Gregory: The Sun and Stars.

PHYSICAL SOCIETY OF LONDON AND OPTICAL SOCIETY (Annual Exhibition, at the Imperial College of Science and Technology), 3 to 6 and 7 to 10. —At 4.—H. B. Grylls: The Heape and Grylls Rapid Cinema Machine.—At 8.—Sir Richard Paget, Bart.: The Nature and Artificial Reproduction of Human Speech (Vowel Sounds).

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—D. Fitzwilliams: A Scientific Method of Removing Foreign Bodies.—A. G. T. Fisher: The Pathology and Treatment of Internal Derangements of the Knee-joint.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—R. H. Barfield: Some Experiments on the Screening of Radio Receiving Apparatus.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.—B. K. Das: The Habits of some Indian Fishes.

THURSDAY, JANUARY 3.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 9.30 A.M.—L. MacD. Robison: Ceylon.—At 11.30 A.M.—Sir Richard Gregory: British Climate in Historic Times (Presidential Address).—At 2.—Joint Conference with the Royal Meteorological Society and the Science Masters' Association. Subjects for Discussion: The Place of Meteorological Observations in the School Course—The Teaching of Meteorology and Climatology in Schools.—At 5.30.—Prof. E. de Martonne: A Study of Transylvania.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir William Bragg: Concerning the Nature of Things: The Nature of Crystals—the Diamond (Juvenile Lectures (4)).

PHYSICAL SOCIETY OF LONDON AND OPTICAL SOCIETY (Annual Exhibition, at Imperial College of Science and Technology), 3 to 6 and 7 to 10.—At 4.—Sir Richard Paget, Bart: The Nature and Artificial Reproduction of Human Speech (Vowel Sounds).—At 8.—H. B. Grylls: The Heape and Grylls Rapid Cinema Machine.

INCORPORATED BRITISH ASSOCIATION FOR PHYSICAL TRAINING (at University College), at 5.30.—Major H. J. Selby: The Mental, Moral, and Physical Health of a Nation.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. S. P. Smith: Railway Electrification in Foreign Countries.

FRIDAY, JANUARY 4.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 10.30 A.M.—Conference on The Teaching of Railway Geography.—At 2.30.—Annual Business Meeting.

EUGENICS EDUCATION SOCIETY AND LING ASSOCIATION (at University College), at 3.—Mrs. Hodson: The Teaching of Hygiene and Racial Progress.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Mrs. Julia Henshaw: Camping in the Kootenay, British Columbia (Lecture for Young People).

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Pictorial Group Meeting.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—L. Manico: Economy of Fuel by Removal of Soot from Boiler Tubes.

PHILOLOGICAL SOCIETY (at University College), at 8.—Prof. S. Boyanus: Russian and English Phonetics.

SATURDAY, JANUARY 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir William Bragg: Concerning the Nature of Things: The Nature of Crystals—Ice and Snow (Juvenile Lectures (5)).

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Sir David Prain: Gilbert White and Moral History.

Recent Scientific and Technical Books.

Volumes marked with an asterisk have been received at "NATURE" *Office.*

Mathematics

Dingler, H. Das Problem des absoluten Raumes in historisch-kritischer Behandlung. 8vo. Pp. 50. (Leipzig: S. Hirzel, 1923.) Grundzahl: 1.50 marks.

Eudoxe. Géométrie pure et géométrie descriptive. 8vo. Pp. 32. (Paris: A. Blanchard, 1923.) 2 francs.

Feldman, W. M. Biomathematics: being the Principles of Mathematics for Students of Biological Science. Cr. 8vo. Pp. xix + 398. (London: C. Griffin and Co., Ltd., 1923.) 21*s.* net.*

Fournier, Georges. La Relativité vraie et la gravitation universelle. Demy 8vo. Pp. viii + 130. (Paris: Gauthier-Villars et Cie, 1923.) 7 francs.*

Gauss, C. F. Carl Friedrich Gauss' Werke. Zehnten Bandes Abt. 2. Abhandlung IV. Stäckel: Gauss als Geometer. (Leipzig und Berlin: B. G. Teubner, 1923.) 6*s.* 5*d.*

Gibbs, R. W. M. Constructive Arithmetical Exercises. Cr. 8vo. Part 2. Pp. 277. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1923.) 3*s.* 6*d.* net.

Gillmer, M. Trigonometrie und Stereometrie. (Kollegienhefte, Band 18.) 8vo. Pp. vi + 226. (Leipzig: S. Hirzel, 1922.) 5 Schw. francs.

Küster, F. W., Begründet von. Logarithmische Rechentafeln für Chemiker, Pharmazeuten, Mediziner und Physiker. Nach dem gegenwärtigen Stande der Forschung bearbeitet von A. Thiel. 27-29 verbesserte und vermehrte Auflage. Pp. 132. (Berlin und Leipzig: W. de Gruyter und Co., 1923.)

Loney, S. L. The Elements of Coordinate Geometry. Cr. 8vo. Part 2: Trilinear Coordinates, etc. Pp. viii + 228. (London: Macmillan and Co., Ltd., 1923.) 6*s.**

Mie, Gustav. Die Einstein'sche Gravitationstheorie: Versuch einer allgemeinverständlichen Darstellung der Theorie. Zweite Auflage. Large 8vo. Pp. iv + 69. (Leipzig: S. Hirzel, 1923.) 1.20 Schw. francs.

Muir, Sir Thomas. The Theory of Determinants in the Historical Order of Development. Demy 8vo. Vol. 4: The Period 1880 to 1900. Pp. xxxi + 508. (London: Macmillan and Co., Ltd., 1923.) 40*s.* net.*

Onnen. Kreisevolventen und ganze algebraische Funktionen. (Math.-physik. Bibliothek, Band 51.) (Leipzig und Berlin: B. G. Teubner, 1923.) 9*d.*

Tropfke, J. Geschichte der Elementarmathematik in systematischer Darstellung mit besonderer Berücksichtigung der Fachwörter. Roy. 8vo. Vierter Band: Ebene Geometrie. Zweite, verbesserte und sehr vermehrte Auflage. Pp. iii + 238. (Berlin und Leipzig: W. de Gruyter und Co., 1923.) Grundzahl: 7.50 marks.

Whipple, George C. Vital Statistics: an Introduction to the Science of Demography. Second edition. Fcap. 8vo. Pp. xiv + 579. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 20*s.* net.*

Physics: Electrical Engineering

Alexander, E. Wireless. (Drane's A B C Series.) 18mo. Pp. 109. (London: Drane's, 1923.) 1*s.* 6*d.* net.

Astruc, Marcel. Magnéto et allumage. Pp. 215. (Paris: Libr. Berger-Levrault, 1923.)

Ballhatchet, A. V. How to Make a Valve Receiving Set. Fcap. 8vo. Pp. 41. (London: P. Marshall and Co., 1923.) 6*d.* net.

Birkhoff, George D., with the coöperation of **Langer, R. E.** Relativity and Modern Physics. Demy 8vo. Pp. xi + 283. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1923.) 18*s.* 6*d.* net.*

Bohr, Niels. Les Spectres et la structure de l'atome: trois conférences. Traduit par A. Corvisy. 8vo. Pp. 150. (Paris: J. Hermann, 1923.) 8 francs.

Brillouin, M. Théorie électrique moderne de l'état solide. 8vo. Pp. 24. (Paris: Société française des Électriciens, 1923.)

Croft, Terrell, Edited by. Practical Heat. (Power Plant Series.) Large Cr. 8vo. Pp. xiii + 713. (New York and London: McGraw-Hill Book Co., Inc., 1923.) 25*s.**

Dull, Charles E. Essentials of Modern Physics. Cr. 8vo. Pp. xi + 525. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1923.) 5*s.**

Egan, Michael. The Complete Wireless. Demy 4to. No. 2: How to Make your Own Receiving Set. Pp. 40. (London: G. Newnes, Ltd., 1923.) 1*s.* net.

Fleming, J. A. Waves and Ripples on Water, Air and Aether: being the 76th Course of Christmas Lectures delivered at the Royal Institution of Great Britain. Fourth issue, revised. Cr. 8vo. Pp. xii + 299. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1923.) 7*s.* 6*d.* net.

Grierson, R. Electric Lift Equipment for Modern Buildings: a Practical Guide to its Selection, Installation, Operation and Maintenance. Demy 8vo. Pp. xii + 179. (London: Chapman and Hall, Ltd., 1923.) 15*s.* net.

Hay, Alfred. Alternating Currents: their Theory, Generation and Transformation. Fifth edition, revised and enlarged. Demy 8vo. Pp. 436. (London: Harper and Bros., 1923.) 8*s.* 6*d.* net.

Henderson, J., and Marshall, C. W. A.C. Protective Systems and Gear: a Practical Introduction to the Methods and Equipment used to protect High-Tension Alternating-Current Systems from the Effects of Faults, with Notes on the Latter, the Determination of Short-Circuit Current, and the Testing of Protective Devices; for Operating Engineers, Students and Manufacturers. (Pitman's Technical Primers.) Fcap. 8vo. Pp. xii + 108. (London: Sir I. Pitman and Sons, Ltd., 1923.) 2*s.* 6*d.* net.*

Karapetoff, Vladimir. Experimental Electrical Engineering and Manual for Electrical Testing: for Engineers and for Students in Engineering Laboratories. Med. 8vo. Vol. I. Third edition, completely revised and reset. Pp. xxxii + 795. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 30*s.* net.

Kendall, Lewis F., and Koehler, Robert P. Radio Simplified: What it is; How to Build and Operate the Apparatus. Cr. 8vo. Pp. 271. (London: Stanley Paul and Co., 1923.) 5*s.* net.

Kohlrausch, Friedrich. Lehrbuch der praktischen Physik. 14 stark vermehrte Auflage. Demy 8vo. Pp. xxviii + 802. (Leipzig und Berlin: B. G. Teubner, 1923.) Grundzahl: 12 marks.

Larner, Edgar T. Alternating Currents, their Theory and Transmission: for Electrical Engineering Students; including "The Principles of Alternating Currents." (Lockwood's Technical Manuals.) Cr. 8vo. Pp. viii + 198. (London: C. Lockwood and Son, 1923.) 6*s.* net.

Luckiesh, M. Ultraviolet Radiation: its Properties, Production, Measurement and Applications. Med. 8vo. Pp. xi + 258 + 12 plates. (London: C. Lockwood and Son, 1923.) 21*s.* net.*

McDougall, A. T. Nature's Mystic Movements: Heat, Light and Sound. Cr. 8vo. Pp. 207. (London: Sir I. Pitman and Sons, Ltd., 1923.) 2*s.* 6*d.* net.

Malgorn, G. Radiotélégraphie et Radiotéléphonie à la portée de tous. Med. 8vo. Pp. 231. (Paris: Gauthier-Villars et Cie, 1923.) 10 francs.

Moore, H. A Textbook of Intermediate Physics. Demy 8vo. Pp. ix + 824. (London: Methuen and Co., Ltd., 1923.) 22*s.* 6*d.* net.*

Ollivier, H. Cours de physique générale à l'usage des candidats au certificat de physique générale, au diplôme d'ingénieur-électricien et à l'agrégation des sciences physiques. Roy. 8vo. Tome troisième: Mouvements vibratoires, acoustique, optique physique, ondes électromagnétiques, électro-optique, effets optiques du mouvement. Deuxième édition, entièrement refondue. Pp. 712. (Paris: J. Hermann, 1923.) 45 francs net.*

Pacoret, E. Les Forces hydrauliques et les usines hydroélectriques (aménagement des chutes d'eau et des centrales électriques). Pp. 452. (Paris: Libr. Delagrave, 1923.) 15 francs.

Pringsheim, Peter. Fluorescenz und Phosphorescenz im Lichte der neueren Atomtheorie. Zweite verbesserte Auflage. Demy 8vo. Pp. viii + 228. (Berlin: J. Springer, 1923.) 7*s.* 1*d.**

Pye, D. R. Heat and Energy. (Clarendon Science Series.) Cr. 8vo. Pp. xii+211. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 5s. net.*

Redpath, E. How to Make a "Unit" Wireless Receiver. (Radio Press Series, No. 7.) Fcap. 8vo. Pp. 88. (London: The Radio Press, Ltd., 1923.) 2s. 6d. net.

Redpath, E. Wireless Licences and How to Obtain Them. (Radio Press Series, No. 11.) Fcap. 8vo. Pp. 51. (London: The Radio Press, Ltd., 1923.) 1s. net.

Reynaud-Bonin, E. Radiotélégraphie, radiotéléphonie, radioconcert. Demy 8vo. Pp. vi+178. (Paris: Gauthier-Villars et Cie, 1923.) 10 francs.*

Roy, Louis. L'Électrodynamique des milieux isotropes en repos d'après Helmholtz et Duhem. (Collection "Scientia," No. 40.) Fcap. 8vo. Pp. 94. (Paris: Gauthier-Villars et Cie, 1923.) 10 francs.

Smith, Alpheus W. The Elements of Applied Physics. Med. 8vo. Pp. xiv+483. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 12s. 6d.*

Urquhart, J. W. Electric Light Fitting: a Handbook for Working Electrical Engineers. Cr. 8vo. Pp. 175. (London: C. Lockwood and Son, 1923.) 5s. net.

Vitus, Fernand. ABC de téléphonie sans fil. (Collection des ABC.) Fcap. 8vo. Pp. 122. (Paris: Libr. Delagrave, 1923.) 4 francs.

Chemistry: Chemical Industry

Arnold, Karl. Repetitorium der Chemie. Mit besonderer Berücksichtigung der für die Medizin wichtigen Verbindungen sowie des Deutschen Ärzneibuches und anderer Pharmakopöen, namentlich zum Gebrauche für Mediziner und Pharmazeuten. 16 neubearbeitete Auflage. Pp. 500. (Leipzig: L. Voss, 1923.) Grundzahl: 9 marks.

Barrett, W. H. Elementary Physical Chemistry. Cr. 8vo. Pp. viii+247. (London: E. Arnold and Co., 1923.) 6s.*

Bauer, K. H., Herausgegeben von. Chemie-Büchlein: ein Jahrbuch der Chemie. 2 Jahrgang. Pp. 76. (Stuttgart: Franckhsche Verlagshandlung, 1923.)

Bauer, K. H. Monographien aus dem Gebiete der Fett-Chemie. Teil II.: Leim und Gelatine. Von R. Kissling-Bremen. Pp. 214. (Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H., 1923.)

Beyer, Oskar. Handbuch der Saccharin-Fabrikation. Pp. 143. (Zürich: Rascher und Co., 1923.)

Bloxam, Charles L. Chemistry, Inorganic and Organic: with Experiments. Eleventh edition, revised by A. G. Bloxam and S. J. Lewis. Roy. 8vo. Pp. x+832. (London: J. and A. Churchill, 1923.) 36s. net.*

Born, Max. The Constitution of Matter: Modern Atomic and Electron Theories. Translated from the second revised German edition by E. W. Blair and T. S. Wheeler. Demy 8vo. Pp. vii+80. (London: Methuen and Co., Ltd., 1923.) 6s. net.*

Coffignier, C. Varnishes: their Chemistry and Manufacture. Translated from the French by Arthur H. J. Keane. Roy. 8vo. Pp. viii+548. (London: Scott, Greenwood and Son, 1923.) 21s. net.

Cooper, F. J. Textile Chemistry: an Introduction to the Chemistry of the Cotton Industry. Demy 8vo. Pp. ix+235. (London: Methuen and Co., Ltd., 1923.) 10s. 6d. net.*

Cooper, W. R. Electro-Chemistry related to Engineering. (A Treatise on Electro-Chemistry, edited by Bertram Blount.) Demy 8vo. Pp. xiv+136. (London, Bombay and Sydney: Constable and Co., Ltd., 1923.) 12s. 6d. net.*

Damiens, A. Les Isotopes. Roy. 8vo. Pp. ix+118. (Paris: Gauthier-Villars et Cie, 1923.) 12 francs.*

Department of Glass Technology: The University, Sheffield. Experimental Researches and Reports. Vol. 5, 1922. Ex. Cr. 8vo. Pp. 138. (Sheffield: The University, 1923.)*

Department of Scientific and Industrial Research: Fuel Research Board. Technical Paper No. 6: Comparisons of some Methods of Running Water-Gas Plant; a Record of Experiments at H.M. Fuel Research Station. By James G. King and J. Fraser Shaw. Roy. 8vo. Pp. iv+31. (London: H.M. Stationery Office, 1923.) 2s. net.*

Doemens, Dr. Tabellen zur Malz- und Bieranalyse. 2 Auflage. Pp. 12. (München und Berlin: R. Oldenbourg, 1923.) Grundzahl: 0.80 marks.

Evans, Ulick R. Metals and Metallic Compounds. In 4 vols. Demy 8vo. Vol. 3: The Transition Elements. Pp. xii+270. 14s. net. Vol. 4: Metals of the "B" Groups. Pp. xii+350. 18s. net. (London: E. Arnold and Co., 1923.)*

Fromm, Emil. Einführung in die Chemie der Kohlenstoffverbindungen (Organische Chemie): ein Lehrbuch für Anfänger. Vierte, verbesserte Auflage. Pp. viii+262. (Leipzig und Wien: F. Deuticke, 1923.) Grundzahl: 10 marks.

Heuser, Emil. Lehrbuch der Cellulosechemie: für Studierende an technischen Hochschulen und Universitäten sowie für Cellulose-Fachleute. 2 Auflage. Pp. 211. (Berlin: Gebrüder Borntraeger, 1923.)

Holmes, H. N. General Chemistry. Demy 8vo. Pp. xi+558. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 16s. net.

Joel, Ernst. Klinische Kolloidchemie. Mit einem Geleitwort von K. Spiro. Pp. 124. (Dresden und Leipzig: T. Steinkopff, 1923.) 2s. 2d.

Jones, Harry C. Trattato di chimica fisica. Seconda edizione italiana a cura di Michele Giua. Roy. 8vo. Pp. xxiii+731. (Milano: Ulrico Hoepli, 1923.) 56 lire.*

Kopaczewski, W. Théorie et pratique des colloïdes en biologie et en médecine. Pp. 308. (Paris: Vigot frères, 1923.) 25 francs.

Leslie, E. H. Motor Fuels: their Production and Technology. Pp. 681. (New York: The Chemical Catalog Co., Inc., 1923.) 7 dollars.

Liévin. Les Solutions alcalines d'iode. 8vo. Pp. 144. (Paris: J. Hermann, 1923.)

Lowson, W. Supplementary Notes on Gravimetric Analysis for Beginners. Cr. 8vo. Pp. vi+58. (London: Longmans, Green and Co., 1923.) 2s. 6d.*

Margosches, B. M., und Fuchs, W., Herausgegeben von. Über Naturprodukte: Chemische Abhandlungen zur Kenntnis und Verwertung verschiedener Naturprodukte. Festschrift zum 70 Geburtstage Max Hönig von Fachgenossen, Freunden und Schülern gewidmet. Large 8vo. Pp. x+181. (Dresden und Leipzig: T. Steinkopff, 1923.) Grundzahl: 5.5 marks.

Martin, Geoffrey. Practical Chemistry. Second impression. Cr. 8vo. Pp. 144. (London: C. Lockwood and Son, 1923.) 2s. 6d. net.

Nernst, Walter. Theoretical Chemistry from the Standpoint of Avogadro's Rule and Thermodynamics. Revised in accordance with the eighth-tenth German edition by L. W. Codd. Demy 8vo. Pp. xx+922. (London: Macmillan and Co., Ltd., 1923.) 28s. net.*

Oppenheimer, Carl. Kurzes Lehrbuch der Chemie in Natur und Wirtschaft. Nebst einer Einführung in die allgemeine Chemie von Johann Matula. (Leipzig: G. Thieme, 1923.)

Ostwald, Wolfgang. An Introduction to Theoretical and Applied Colloid Chemistry: "The World of Neglected Dimensions." Authorised translation from the eighth German edition by M. H. Fischer. Second and enlarged American edition. Med. 8vo. Pp. xiii+266. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 12s. 6d. net.*

Pollitt, Alan A. The Causes and Prevention of Corrosion. Cr. 4to. Pp. 230. (London: Ernest Benn, Ltd., 1923.) 25s. net.*

Pope, Sir William J. Matter and Energy: being the Watt Anniversary Lecture for 1923, delivered before the Greenock Philosophical Society on January 12, 1923. Demy 8vo. Pp. 29. (Greenock: The Society, 9 Margaret Street, 1923.)

Poucher, William A. Perfumes and Cosmetics: with Especial Reference to Synthetics. Demy 8vo. Pp. xi+462+47 plates. (London: Chapman and Hall, Ltd., 1923.) 21s. net.*

Roth, Walther A., und Scheel, Karl, Herausgegeben von. Konstanten der Atomphysik. Unter besonderer Mitwirkung von E. Regener. Imp. 8vo. Pp. 114. (Berlin: J. Springer, 1923.) 8s. 4d.*

Sabatier, Paul. Catalysis in Organic Chemistry. Translated by E. Emmet Reid. Med. 8vo. Pp. xxiv+406. (London: The Library Press, Ltd., 1923.) 25s. net.*

Scheithauer, W. Shale Oils and Tars and their Products. Translated from the German. Second edition, revised and enlarged, by H. B. Stocks. Pp. vii + 283. (London: Scott, Greenwood and Son, 1923.) 12*s.* 6*d.* net.

Sommerfeld, Arnold. Atomic Structure and Spectral Lines. Translated from the third German edition by Henry L. Brose. Demy 8vo. Pp. xiii + 626. (London: Methuen and Co., Ltd., 1923.) 32*s.* net.*

Sornet, R. La Technique industrielle des parfums synthétiques. Demy 8vo. Pp. vii + 135. (Paris: Gauthier-Villars et Cie, 1923.) 10 francs.

Staudinger, Hermann. Anleitung zur organischen qualitativen Analyse. Ex. Cr. 8vo. Pp. xiv + 94. (Berlin: J. Springer, 1923.) 3*s.**

Vickers, C. Metals and their Alloys: a Modern Practical Work dealing with Metals from their Origin to their useful Application—both individually and as parts of alloys—used where Strength, Ductility, Toughness, Lightness, Colour, Hardness, Cheapness, Conductivity, or Bearing Properties are demanded. Partly based on the third edition of "Metallic Alloys," by William T. Brannt. Med. 8vo. Pp. 786. (London: C. Lockwood and Son, 1923.) 50*s.* net.

Walker, William H., Lewis, Warren K., and **McAdams, William H.** Principles of Chemical Engineering. Med. 8vo. Pp. ix + 637. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 25*s.**

Wallis, T. E. Analytical Microscopy: its Aims and Methods. Cr. 8vo. Pp. viii + 149. (London: E. Arnold and Co., 1923.) 6*s.* net.*

Webb, H. W. Absorption of Nitrous Gases. Demy 8vo. Pp. viii + 372. (London: E. Arnold and Co., 1923.) 25*s.* net.*

Weissgerber, Dr. Chemische Technologie des Steinkohlenteers mit Berücksichtigung der Koksbereitung. Pp. 141. (Leipzig: O. Spamer, 1923.) 4*s.* 2*d.*

West, Clarence J. Fine and Research Chemicals. Second revision. Compiled for the Committee on Research Chemicals, Division of Chemistry and Chemical Technology. (Reprint and Circular Series of the National Research Council, No. 44.) Sup. Roy. 8vo. Pp. 45. (Washington: National Academy of Sciences, 1923.) 50 cents.*

Wilson, J. A. The Chemistry of Leather Manufacture. (American Chemical Society Monograph Series.) 8vo. Pp. 343. (New York: The Chemical Catalog Co., Inc., 1923.) 5 dollars.

Technology

Barba, Alvaro A. El Arte de los metales (Metallurgy). Translated from the Spanish by R. E. Douglass and E. P. Mathewson. Imp. 16mo. Pp. ix + 288. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 17*s.* 6*d.* net.*

Blanchard, Mary M. The Basketry Book. 8vo. Pp. 111. (London: B. T. Batsford, Ltd., 1923.) 16*s.* net.

Buchner, G. Hilfsbuch für Metalltechniker: Einführung in die neuzeitliche Metall- und Legierungskunde, erprobte Arbeitsverfahren und Vorschriften für die Werkstätten der Metalltechniker, Oberflächenveredlungsarbeiten u. a. nebst wissenschaftlichen Erläuterungen. Dritte, neubearbeitete und erweiterte Auflage. Pp. xiii + 397. (Berlin: J. Springer, 1923.) Grundzahl: 10 marks.

Cotter, A. La Corporation de l'acier. Traduit de l'anglais par A. Aude. 8vo. Pp. 238. (Paris: Libr. Vuibert, 1923.) 10 francs.

Heuser, Prof. Dr. Technik und Praxis der Papier-Fabrikation. Band II/1: Die Fabrikation des Zellstoffes aus Holz; Sulfit-Zellstoff. Von Richard Dieckmann. Pp. viii + 360. (Berlin: Otto Elsner Verlagsgesellschaft m.b.H., 1923.) 20*s.*

Heylin, Henry B. The Cotton Weaver's Handbook: a Practical Guide to the Construction, Costing, Testing and Manufacturing of Cotton Fabrics; with Studies in Design. Second edition, revised. Cr. 8vo. Pp. 444. (London: C. Griffin and Co., Ltd., 1923.) 15*s.* net.

Jenkins, A. H. Educational Handwork, or Manual Training. Second edition. Cr. 8vo. Pp. viii + 246. (London: University Tutorial Press, Ltd., 1923.) 4*s.*

Mathis, J., avec la collaboration de Le Bourhis et Huffschmitt. Le Livret du cordonnier. Pp. 91. (Paris: Libr. Eyrolles, 1923.) 3 francs.

Polkinghorne, R. K. and **M. I. R.** Weaving and other Pleasant Occupations. Demy 8vo. Pp. 223. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1923.) 10*s.* 6*d.* net.

Rambush, N. E. Modern Gas Producers. Gl. 4to. Pp. xix + 545. (London: Benn Bros., Ltd., 1923.) 55*s.* net.*

Astronomy

Clark, Daniel N. The Universal Law of Organic Progress: a Colligated Presentation. Med. 8vo. Pp. 27. (Los Angeles: Ingersoll and Harrison, 1922.) 15 cents.*

Fenner, E. G. Everybody's Book of Astronomy. (Nature Lovers' Library.) 18mo. Pp. 144. (London: Holden and Hardingham, Ltd., 1923.) 4*s.* 6*d.* net.

Fetlaar, J. A Contribution to the Theory of Eclipsing Binaries. (Recherches Astronomiques de l'Observatoire d'Utrecht, IX., Part 1.) Med. 4to. Pp. iii + 96. (Utrecht: J. Van Boekhoven, 1923.)*

Leuschner, A. O. Celestial Mechanics: a Survey of the Status of the Determination of the General Perturbations of the Minor Planets. (Bulletin of the National Research Council, Vol. 4, Part 7, No. 25.) Sup. Roy. 8vo. Pp. 73. (Washington: National Academy of Sciences, 1922.) 1 dollar.*

Maillard, Louis. Quand la lumière fut. 8vo. Tome II: Les Cosmogonies modernes. Pp. 275 + 36 planches. (Paris: Les Presses Universitaires de France, 1923.)

Nordmann, Charles. Le Royaume des cieux: un peu du secret des étoiles. Cr. 8vo. Pp. 260. (Paris: Hachette et Cie, 1923.) 7 francs.

Olcott, William T. The Book of the Stars for Young People. 8vo. Pp. 431. (London: G. P. Putnam's Sons, 1923.) 15*s.* net.

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